NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **1 July 2003.** For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I option should address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I proposals, including the option, have a 25-page limit (see section 3.3). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

ALL PROPOSALS TO THE NAVY SBIR PROGRAM MUST BE SUBMITTED ELECTRONICALLY.

It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR website at **http://www.dodsbir.net/submission**. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the **6:00 a.m. EST, 14 August 2003** deadline. A hardcopy will NOT be required. A signature by hand or electronically is not required when you submit your proposal over the Internet.

Acceptable Formats for Online Submission: All technical proposal files must be in Portable Document Format (PDF) for evaluation purposes – do not lock/protect your file. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets. You are required to include your company name, proposal number and topic number as a header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the form available through this website. Technical Proposals should conform to the limitations on margins and number of pages specified in the front section of this DoD Solicitation. However, your on-line Cost Proposal will only count as one page and your Cover Sheets will only count as two, no matter how they print out. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission to avoid complications or delays in downloading your Technical Proposal. To verify that your proposal has been received, click on the "Check Proposal" icon to view your proposal. Typically, your proposal will be uploaded within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

PHASE I ELECTRONIC FINAL REPORT:

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR website at: **http://www.onr.navy.mil/sbir**, click on "Submission", then click on "Submit a Phase I or II Summary Report".

ADDITIONAL NOTES:

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program office noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officer's Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 1 of this Introduction. The information required by the Navy, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been **invited** to submit a Phase II proposal by that Activity's proper point of contact, listed in Table 1, during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in

Table 1. The Navy will also offer a "Fast Track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of this solicitation). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR project; 2) A separate 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. **Each of the Navy Activities have different award amounts and schedules; you are required to get specific guidance from that Activity's SBIR Program Manager before submitting your Phase II proposal**. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). The Transition/Marketing plan must be a separate document that is submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir** under "Submission" and also included with the proposal submission online. All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline. The Navy Activity that invited your PH II may also require a hardcopy or your proposal.

All Phase II award winners must attend a one-day Commercialization Assistance Program (CAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit **http://www.navysbir.com/cap**.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefit. It should require minimal work from the contractor because most of this information is required in the final report.

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds for $1,000,000 match of acquisition program funding, can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

Effective in Fiscal Year 2000, a Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II

SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The governments prime contractors and/or their subcontractors will follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect data rights of the SBIR company.

TABLE 1. NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS

Topic Numbers	Point of Contact	Activity	Phone
N03-156 thru N03-167	Mr. Rod Manzano	MARCOR	703-432-3295
N03-168 thru N03-201	Mrs. Carol Van Wyk	NAVAIR	301-342-0215
N03-202 thru N03-221	Mr. Dick Milligan	NAVSEA	202-781-3747
N03-222 thru N03-227	Ms. Cathy Nodgaard	ONR	703-696-0289

Do not contact the Program Managers for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 1 May until 1 July 2003. These topic authors are listed on the Navy website under “Solicitation” or the DoD website. After 1 July, you must use the SITIS system listed in section 1.5c at the front of the solicitation or go to the DoD website for more information.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Make sure you have added a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Your technical proposal has been uploaded. The DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 14 August 2003.

____3. After uploading your file and it is saved on the DoD submission site as a PDF file, review it to ensure that it appears correctly and is readable.

____4. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy 03.2 Topic List

MARCOR

N03-156	Lightweight Materials for the Expeditionary Fuel System (EFS)
N03-157	Thermal and acoustic barriers for the AAAV
N03-158	Damage Characterization Assessment of Circuit Cards through Nanotechnology
N03-159	On-The-Move Individual Water Purification
N03-160	Visual Non-Lethal Area Denial to Personnel
N03-161	Improved Hexavalent Chromium-Free Primer, with Reduced Volatile Organic Compounds (VOCs)
N03-162	Non-Woven Textile Technologies
N03-163	Remote Non-Contact Personnel Incapacitation System
N03-164	Multi-Band Air Defense/Air Search Radar
N03-165	Reduction of Ground Vehicle Observables
N03-166	Remote Perimeter Security System
N03-167	Low Cost High Strength High Toughness Corrosion Resistant Materials for Marine Corps Advanced Amphibious Assault Vehicle (AAAV)

NAVAIR

N03-168	Innovative and Scalable Manufacturing Process for Aerospace Grade Titanium Casting
N03-169	Incorporation of Analysis Enhancements of a p-Element Analysis Code Required for Implementing the Strain Invariant Failure Theory
N03-170	Protective Conformal Coating System (Non-Chromate) for Aircraft Radar Systems
N03-171	Very Low Volatile Organic Compound (VOC) Spray Application Process for Iron Filled Elastomeric (IFE) Coatings
N03-172	Quick Cure Long-Shelf-Life Liquid Shim
N03-173	Video Data Compression
N03-174	Multi-Sensor Terrain Fusion
N03-175	Integrated Laser Electronics
N03-176	Optimized and Rapid Employment of Loitering Weapons in Response to Calls for Fire
N03-177	Innovative Aircraft/Ship Visual Landing Aid (VLA) Test Tool
N03-178	Built-In-Test (BIT) Fiber-Optic Transceiver Circuit
N03-179	On-Board Real-Time Generator Component Failure Diagnostics
N03-180	Automated Measurement/Alignment of Immersive Visual Displays
N03-181	Global Information Grid (GIG)-Enabling Middleware (MW) Portals
N03-182	Integrated Communication Link and Global Positioning System (GPS) for Enhanced, Robust Position Information
N03-183	Miniature Low-Cost Bandwidth Efficient Advanced Modulation (BEAM) Transceiver for Small Uninhabited Aerial Vehicles (UAVs)
N03-184	Active Balancing for Lift Fan Drive Shaft
N03-185	High-Temperature Lubricant
N03-186	Lift Fan Clutch Plate Material
N03-187	High Fuel-to-Air Ratio (FAR) Development Tool
N03-188	High Source Level Plasma Sparkers Driven by High-Energy Density Capacitors for Navy Applications
N03-189	Sonobuoy Networking Technology
N03-190	Helicopter Operations Aircrew/Crew Chief Trainer
N03-191	Imagery Automatic Extraction/Precision Placement of Wavelength-Independent Texture (WIT)
N03-192	Enhanced Understandability and Effectiveness for Joint Strike Fighter (JSF) Automatic Logistic Products
N03-193	Non-Chromated Flexible Aircraft Primer Containing Zero Volatile Organic Compounds (VOCs)
N03-194	High-Bandwidth Photodetector for Missile Applications
N03-195	Diagnostic and Health Monitoring Techniques for Engine Nozzle Actuation Hardware

N03-196	Techniques, Processes, and Tools for Managing the Relationship between Diagnostic and Prognostic Capabilities as Applied to Health Management Systems
N03-197	Techniques and Prognostic Models to Relate Useful Life Remaining and Performance Life Remaining Predictions to Detectable Fault Conditions in Electronic System Power Supplies
N03-198	Dual-Band Electro-Optic (EO)/Infrared (IR) Multifunctional Pod Windows
N03-199	Low-Cost High-Power Laser Designator/Rangefinder for Intelligence, Surveillance, and Reconnaissance (ISR) Platforms
N03-200	Automated On-Board and Off-Board Data Timing and Synchronization
N03-201	An Integrated Antenna Set for Software Radios

NAVSEA

N03-202	Combat System Automation Management
N03-203	Human Performance Measurement Thresholds
N03-204	Fast Cure Primer and Non-Skid System and/or a Single Coat Non-Skid System
N03-205	Casualty Power Electrical System Status Monitoring and Reconfiguration Management
N03-206	Oil-in-Water Emulsion Breaking System for Bilge Water
N03-207	Tools for inter-component dependency identification and failure mode and effects analysis.
N03-208	Tools for testing and certification of distributed, dynamic configurations of a total ship computing environment.
N03-209	SiC Power Converter
N03-210	Human Systems Integration in Netted Systems: Support for Watch Turnover
N03-211	High Damping Resin for Impregnation of Propulsion Scale Electric Machinery
N03-212	Plug and Play for Combat Electronics
N03-213	Firmware Analysis Test System
N03-214	Multi-Axis Fiber Optic Strain Sensor and High-Speed Multiplexing System.
N03-215	Wideband Digital Beamforming and Direction Finding
N03-216	Total Ship Management System (TSMS) Operator Assistant
N03-217	Conformal X-Bank Seeker for Semiactivee Guided Projectile
N03-218	Laser Designtor for Mk 46 Optical Sight System
N03-219	Minimum Bandwidth Distributed Simulations for Warfighter Shipboard Training
N03-220	Extensible AAR Acquisition, Retrieval, and Storage System (EAARS)
N03-221	Bubble Detection Using Pulse-Echo Ultrasound

ONR

N03-222	Multiple-Beam Electron Gun for Radar Applications
N03-223	Autonomous Biological and Chemical Oceanographic Instrumentation
N03-224	Sensor/Sensor – Sensor/Weapon Connectivity Technology
N03-225	Underwater X-ray imager and scatterometer for ROVs and AUVs
N03-226	Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation
N03-227	Aerosol Mass Spectrometer for Aircraft Sampling.

Navy 03.2 Topic Descriptions

N03-156 TITLE: Lightweight Materials for the Expeditionary Fuel System (EFS)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: PM Engineering Systems

OBJECTIVE: One of the most difficult logistics operations is ensuring that adequate amounts of fuel are available to combat units when and where it is required. History has verified that adequate fixed-petroleum facilities are not available where they are required to support even the smallest fighting force. There is not currently an efficient mechanism to move fuel to the High Water Mark (HWM) until the Maritime Prepositioning Force (MPF) arrives. A seamless transition from ship to shore is needed. The current design for the EFS modules uses welded aluminum enclosures that are too heavy to be man portable. The objective of this SBIR is to reduce the weight of the EFS modules using composites or other advanced material designs.

DESCRIPTION: The Marine Corps needs a system comprised of individual tank modules mounted to a unique transport pallet that can break down for transport aboard amphibious shipping, yet assemble to provide a Department of Transportation (DOT) certifiable 400-gallon fuel tank. The lightweight EFS modules must be affordable, lighter and more robust than the current aluminum modules.

While the concept was successfully demonstrated FY 2001, the prototype tanks were too heavy to meet requirements for production. The EFS modules consisted of a series of 400-gallon fuel pods that can be interconnected with other pods, used separately or collapsed during storage. A detailed briefing on the EFS 400 is provided at the referenced website.

The EFS 400's tank is currently welded aluminum with a coated fabric liner. The assembled tank has a capacity of 360 gallons. It weighs roughly 600 pounds empty, 3,000 pounds when filled with JP-8 and is compatible with Marine Corps' 4k RT forklift. All tanks can be filled or drained simultaneously through the 4-inch camlock fittings located on the transport pallet making the EFS 400 operate like conventional bulk transport container. For storage aboard ship, the individual tanks breakdown into 44 inches x 44 inches x 45 inches and can be double stacked and stored below deck.

PHASE I: Conduct a structural analysis to determine material selection criteria. Conduct a trade study to evaluate the attributes of various advanced materials and processes for this application. Develop a system design for a lightweight EFS module.

PHASE II: Produce a prototype system and develop test metrics. Conduct technical testing to include basic functions as well as environmental testing. Assess results and modify design as applicable. Deliver 10 modules to the government for field evaluation. Document results in a technical report.

PHASE III: Market the technology developed under this program to other military or commercial platforms where lightweight fuel storage tanks are used. Participate as a prime or sub-contractor to a prime responding to the future solicitation for EFS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be easily adapted to suit commercial operations such as refueling heavy equipment at remote locations. The lightweight materials technology could be adapted for use in automobiles and boats.

REFERENCES: www.marcorsyscom.usmc.mil&t.ppt

KEYWORDS: Advanced Materials, Lightweight, and Fuel Distribution & Storage

N03-157 TITLE: Thermal and acoustic barriers for the AAAV

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: AAAV, ACAT ID

OBJECTIVE: To identify affordable lightweight materials that will provide both thermal and acoustic barriers. The barrier materials will be used adjacent to hull frames around components (engine, PTM, transmission ...) of Al2519 and around internal vehicle components that present hazards to the crew and embarked infantry.

DESCRIPTION: Insulation technologies continue to advance in the commercial marketplace. The intent of this SBIR is to identify potential superior insulation materials and acceptable packaging techniques to permit their use in a combat vehicle. The AAAV is an amphibious assault vehicle with extreme performance requirements. The performance requirements of the vehicle result in several hot and/or noisy pieces of equipment including the engine, transmission, power transfer module, and cooling fans. In additional to the thermal and acoustic properties of the insulation materials, the complete system must be resistant to water, oil, diesel fuel, and hydraulic fluid and exhibit a high level of durability. The insulation material chosen should be resistant to corrosion and erosion, but also not contribute, by itself or in contact with the materials of the components it is required to protect, to various forms of corrosion – general, crevice, and galvanic. If corrosion protection has to be applied, the material chosen has to be compatible with the corrosion protection methods used (system of primers and topcoat paints) currently for the AAAV.
Material criteria include:
1. K value 0.0305 BTU/hr-ft-deg F for 1 inch thickness.
2. Typical Hot side air temperature is 200F.
3. Typical Cool side air temperature is 95F.
4. Cool side surface temperature must not exceed 120F.
5. Material needs to cause acoustic attenuation. Transmission Loss:

Octave Band Frequency - f (Hz)	TL (Db)
125	20
250	25
500	30
1K	35
2K	40
4K	42
8K	45

6. STC (Transmission Loss Factor) 32-36
7. Weight cannot exceed 3lbs per sqft.

Also materials used to construct the panel/ treatment shall:
1. Use NO Ozone depleting substances.
2. Use NO carcinogens.
3. Use NO flammable substances (Flash point below 100 F).
4. Use NO material that will evolve toxic fumes when heated.
5. Use material that is resistant to corrosion by itself or in contact with other materials of the equipment it is required to provide thermal protection.

A tailorable or a graded system would be highly desirable, as some areas would need more thermal protection and others more acoustic protection. In addition to the properties listed above, the objective insulation system must be lightweight, affordable, and fit into a minimal space claim.

PHASE I: Potential insulation materials that could survive the demanding service environment of the AAAV should be identified and performance data should be collected either through testing or data searches. In addition to the insulation materials, a packaging approach that would provide the durability in the environment should be investigated. A single material solution is not required; multiple material configuration solutions are acceptable.

PHASE II: Full-scale prototype insulation systems should be fabricated and tested on the vehicle to verify both insulation performance and ability to survive in the environment. As necessary, corrosion testing of the material chosen should be performed to insure that the material is corrosion resistant and will not cause/contribute to corrosion in contact with component materials. The insulation systems may be tailored for each application on the vehicle if necessary. Integration issues regarding actual implementation of the system into the various vehicle systems should be resolved.

PHASE III: Develop a vehicle kit for AAAV that could be procured.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An affordable lightweight robust insulation system could have applications ranging from improved home thermal insulation, to sound insulation in automobiles, and even into personal outerwear.

REFERENCES:

1. Advanced Amphibious Assault Website – www.aaav.usmc.mil
2. MIL-STD-889 – Dissimilar Metals
3. MIL-DTL-64159 – Coating, Water Dispersible Aliphatic Polyurethane, Chemical Agent Resistant
4. MIL-STD-810F, Environmental Engineering Considerations And Laboratory Tests

KEYWORDS: Thermal, Acoustic, Insulation, Lightweight, Corrosion, Affordable

N03-158 TITLE: <u>Damage Characterization Assessment of Circuit Cards through Nanotechnology</u>

TECHNOLOGY AREAS: Materials/Processes, Electronics

ACQUISITION PROGRAM: Program Management Test, Measurement and Diagnostic Equipment (PMTMDE)

OBJECTIVE: Develop a reliable nondestructive assessment technique to quantify microstructure damage and aging effects for existing and new circuit cards in a field environment.

DESCRIPTION: One of the challenges facing the technology used in military platforms today is the inability to quantitatively assess the detailed condition of circuit cards in critical applications in the field.
Damage and aging will reduce the effectiveness of these circuit cards, leading to mission degradation and eventual failure.
A new technology is required to effectively provide a three dimensional microstructural evaluation of a circuit card's operational condition.
There have been significant technological advances in prognostic and diagnostics technologies in the areas of microstructural analysis and nanotechnology.

New and radical techniques have demonstrated the capability to probe materials to near atomic resolutions and quantitatively determine the build-up of operational damage as referenced to new and failed components.
The ability to evaluate circuit card condition in a fielded environment would have tremendous potential for numerous joint service applications. Novel and innovative damage assessment technologies are sought that will establish a circuit cards' micro-structural 'signature', by probing at the nano-defect level. This would provide heretofore unprecedented empirical information on the circuit card's actual condition and suitability for the assigned mission.

The resolution of component level failures of discrete components (resistors, capacitors, inductors), to integrated circuits, and including solder joint failure, via failures, cracks and delamination of the printed circuit board itself are some key failure areas. Across the DoD, enormous numbers of circuit cards exist, ranging from single layer seventies technology-based circuit cards to advanced multilayer circuit cards using multiple processors. Failure analysis could also extend within the integrated circuit itself, allowing visibility of circuit electromigration and other effects. A benefit to the successful implementation of this technology would be not only accurate fault diagnosis, but the potential to detect impending failure as well. This then would provide an empirical basis for the eventual development of true prognostics.

PHASE I: Using nanotechnology or other novel approaches, determine the feasibility to quickly and accurately measure controlled microstructure damage accumulation in operational circuit cards using advanced microstructural analysis technologies. Establish the correlation between the parameters of measurement response and damage/aging accumulation in circuit cards such that a signature technology for three dimensional evaluation of circuit cards could be developed. This will occur with no modifications to existing or new circuit cards.

PHASE II: Develop a damage evaluation technique prototype that will establish relationships between the level of microstructure damage and operational aging in circuit cards used in military platforms. Demonstrate the accuracy of the technique to determine the operational structural signature of circuit cards as referenced to the applicable referenced "gold standard" of a series of known good circuit cards.

PHASE III: Develop the prototype for a field demonstration of damage evaluation of operational circuit cards for specific DoD platform applications and transition to the fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed novel technology would have broad civilian impact for detection and isolation of operational damage and aging of circuit cards in numerous commercial applications.

REFERENCES:
1. Schultz, P.J., and C.L. Snead, Jr., 1990. "Positron Spectroscopy for Materials Characterization," Metallurgical Transactions, 21,4, May, pp.1121-1131.

2. Josh Chamot jchamot@nsf.gov; (703) 292-8070; Filbert Bartoli fbartoli@nsf.gov; (703) 292-8339
"Laser-Like Beam May Break Barriers to Technological Progress"NSF PR 02-60 - July 18, 2002.

3. Ice, Gene, Metals and Ceramics Division ORNL,
Larson, Ben, Solid State Division ORNL. 2000 http://www.ornl.gov
"New Tool Gives Scientists Inside Look At Materials" http://www.sciencedaily.com/releases/2000/02/000215064018.htm

4. S. Fleischer, Y.F. Hu, C.D. Beling, S. Fung, T.L. Smith, K.M. Moulding,
H.M. Weng, M. Missous, 1999
"Positron beam study of low-temperature-grown GaAs with
aluminum delta layers". Applied Surface Science 149 1999 159–164

5. A. van Veen, A.C. Kruseman, H. Schmit, P.E. Mijnarends, B.J. Kooi, and Th. M. DeHosson. "Positron Analysis of Defects in Metals". Materials Science Forum. Vols. 255-257 (1997) pp. 76-80. 1997 Trans Tech Publications Switzerland.

6. "Delving Into The Nanoscopic" Weizmann Institute (http://www.weizmann.ac.il/
http://www.sciencedaily.com/releases/2000/09/000926072113.htm .

KEYWORDS: Circuit Card Assessment; Nanotechnology; Nondestructive Testing; Materials; Signature Technology

N03-159 TITLE: <u>On-The-Move Individual Water Purification</u>

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT IV: Infantry Combat Equipment (ICE)

OBJECTIVE: The objective is to produce 3 liters of potable water in 3 minutes from any water source to include brackish and salt water.

DESCRIPTION: On-The-Move individual water purification system will make potable water in any environment. The system will include a water storage capability and delivery system, and filtration components. The delivery/ storage source shall be NBC resistant. The system must produce at least 300 liters of potable water before maintenance and weigh less than 24 ounces. A threshold requirement for this system is to make 3 liters of potable water in 10 minutes from a fresh water source. The individual Marine requires 1.5 to 3 gallons of drinking water per day depending on the environment. This equates to 12 to 24 pounds of water they must carry for each day they will be in the field without re-supply. No technology exists that will allow Marines on the battlefield to purify water in every environment. Technology exists that will purify water in certain environments to USEPA Standards for Microbiological Purifiers (bacterial removal to 6 logs, viral removal to 4 logs, and protozoan cyst removal to 3 logs). Compliance with this standard is defined in TB/MED 577. It is desired to introduce a capability to make potable water from any water source encountered in the battlefield. The end-state is a man-portable, on the move individual water purification system that will integrate with current and future USMC equipment.

PHASE I: Develop concepts for a small, man portable on-the-move individual water purification systems. Evaluate the pros and cons of each concept to include the following factors: size, weight, reliability/durability, purification and filtration capabilities, safety and associated health hazards. Conduct a trade off analysis of these concepts that considers manufacturing cost, life cycle cost, logistics considerations and performance. Demonstrate concept feasibility for the generation of drinking water in a laboratory environment. Based on the information developed by the end of the Phase I, make recommendations for a system that can be demonstrated in Phase II.

PHASE II: Select a concept from Phase I and develop prototypes. Conduct laboratory testing to demonstrate compliance with USEPA Standards for Microbiological Purifiers. Select a concept for further consideration and assemble enough prototypes to conduct a field evaluation. The Marine Corps will conduct the field evaluation and provide feedback to the contractor. Results from the Phase II development and field evaluation will be documented in a final report.

PHASE III: Manufacture the device for the military, emergency response agencies and commercial sporting industry to develop a large enough consumer base to bring production cost down.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial sporting industry has a very large market for devices that include a water purification component. Quantities for the commercial market would be large enough to provide economies of scale for the military and civilian market alike.

REFERENCES:
1. TB Med 577, Sanitary Control and Surveillance of Field Water Supplies (see CHPPM website)

2. U.S. Army Center For Health Promotion and Preventative Medicine (CHPPM), http://chppm-www.apgea.army.mil

3. www.watertechonline.com

KEYWORDS: Water-heater, Portable, and Lightweight

N03-160 TITLE: Visual Non-Lethal Area Denial to Personnel

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace, Human Systems

ACQUISITION PROGRAM: ACAT IV: Joint Non-Lethal Weapons Directorate

OBJECTIVE: To explore new non-lethal capabilities in the application of non-coherent sources of light that create a disability or discomforting glare for opposing forces to achieve Area Denial to Personnel and will reduce risks in both noncombatant and combatant casualties, friend or foe and damage to collateral equipment and structures.

DESCRIPTION: The AD-P program desires a device to restrict operations or deny area to personnel in urban/suburban regions (city streets, urban canyons, etc). This device should use a non-coherent light source and optimize visual contrast for a control force and create a disability/discomfort effect for opposing forces. The system should be compatible with existing systems (or those within a year of first unit equipped (FUE)), from various ranges with areas of effectiveness covering 0-500 meters. The effects on personnel can vary from repel, delay, deny, disrupt, or incapacitate.

PHASE I: Develop innovative system concept using non-coherent light for denying an area to Personnel without significant collateral damage or permanent injury. Design a test regime for determining effectiveness.

PHASE II: Optimize Phase I design and demonstrate prototype system against a realistic target. Compare effectiveness vice COTS equipment (e.g. "blue" xenon-arc automobile headlamp).

PHASE III: Optimize prototype system for technology solution(s) and demonstrate effectiveness of complete system. This demonstration should involve human and/or animal test subjects as appropriate, and as such the correct protocols need to be approved.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be used by law enforcement agencies for riot, crowd control, hostage situations and area denial (i.e. bridges, tunnels, power plants and reservoirs). Effort may identify methods of reducing glare in COTS lighting equipment.

REFERENCE:
1. Joint Non-Lethal Weapons Concept, Signed by LtGen M.R. Steele, Deputy Chief of Staff for Plans, Policy, and Operations, U.S. Marine Corps on 1/05/98, Available on World Wide Web at http://www.jnlwd.usmc.mil/

KEYWORDS: personnel; Non-Lethal; Area Denial; glare; visual

N03-161 TITLE: <u>Improved Hexavalent Chromium-Free Primer, with Reduced Volatile Organic Compounds (VOCs)</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT ID – ADVANCED AMPHIBIOUS ASSAULT VEHICLE (AAAV)

OBJECTIVE: To develop an improved primer containing hexavalent chromium-free corrosion inhibitors and reduced VOC, suitable for marine environment and applications

DESCRIPTION: The Marine Corps Advanced Amphibious Assault Vehicle (AAAV) is a 76,000 pound armored vehicle designed to operate over harsh off-road terrain and in oceans and rivers. The AAAV is expected to operate in severe environments such as high humidity, seawater, sand, mud, rocks, gravel, etc. and must be capable of withstanding severe impact and abrasion loads from rock and debris while moving at high speed (45 mph) over rough cross country terrain. Climatic conditions can range from –65 degrees F to +125 degrees F.

It is generally recognized that hexavalent chromium (Cr+6) corrosion inhibitors are significant in contributing to the corrosion protection of aluminum alloys. In view of this, pretreatments and primers with hexavalent chromium inhibitors are generally used in the aviation and to a large extent in other defense and commercial industries to provide corrosion protection to aluminum alloys. Cr+6 is very effective for corrosion protection, including for high copper alloys such as 2519, which cannot be as well protected from corrosion with other non-hexavalent chromium systems. However, Cr+6 is considered a carcinogenic and its use has been restricted in the AAAV Program. Although efforts to move away from the hexavalent chromium system are ongoing, the transition has been mostly in the development of alternatives, some of which are being currently used for the AAAV. The performance of these non hexavalent chromium primers, alone, or in combination with chemical agent resistant (CARC) and other defense system topcoats, is not as good as hexavalent chromium-based primers on difficult to protect aluminum alloys like 2519 and 7050. Currently hexavalent chromium-free primers (MIL-P-53022 and MIL-PRF-85582NC) are used as the primary component of the corrosion-prevention finishing system on the AAAV. These primers contain hexavalent chromium-free corrosion inhibitors, and are reduced with organic solvents or water. The development of new hexavalent chromium-free primers should evaluate and include corrosion inhibitors, such as trivalent chromium (Cr+3), phosphates, silicates, or other corrosion inhibiting species.

Another aspect of these primers is the volatile organic compound (VOC). The Environmental Protection Agency (EPA) has proposed a reduction in low-level ozone non-attainment levels within the National Ambient Air Quality Standards (NAAQS). Because VOCs contribute to the generation of low-level ozone, state and local agencies may require VOC reductions beyond those listed in the aerospace National Emission Standards for Hazardous Air Pollutants (NESHAPs), especially in southern California. This is particularly crucial because a significant amount of AAAV fleet testing and use will occur on bases in California. While the VOC is to be reduced, the advantages derived from solvent based primers should also be maintained in any primers that will be developed.

PHASE I: Provide an initial development effort that incorporates non-hexavalent chromium corrosion inhibitors into a polymeric binder system to produce a sprayable coating with reduced or no organic solvents for use on AAAV platforms. The alternative primer shall perform better than the non-chromate products already qualified to military specifications, MIL-PRF-85582, MIL-PRF -23377, MIL-P-53022, MIL-P-53030, with the goal to match or exceed the performance of hexavalent chromium primers qualified to MIL-PRF-85582 and MIL-PRF-23377. The alternative primer should also be compatible with existing pretreatments and topcoats used on the AAAV and other defense platforms. Additionally, the application of the proposed coating should not interfere with the logistical and operational requirements of the Marine Corps facility tasked to use these coatings.

PHASE II: Develop, test, and field the coating formulated under the Phase I SBIR effort. Comparative tests required include but not limited to ASTM B117, Neutral Salt Fog, ASTM G85, SO2 Salt Fog, GM 9540 Cyclic Corrosion, and Outdoor Exposure. Tests will also include comparative controls from existing military pretreatment, primer, and top coat systems. A detailed report covering the tests performed with the results and recommendations has to be prepared. The developed material and process is to be qualified in coordination with the government. A draft MILSPEC/Commercial specification is to be prepared and coordinated with the government for subsequent issue. Efforts to identify suitable production capable paint manufacturers who have experience in producing and supplying paint systems to the defense and commercial industry and coordinate with them plans to produce the developed material on a production level to support the AAAV production efforts.

PHASE III: Produce the coating demonstrated in the Phase II effort. After a successful field demonstration of the new paint system on selected vehicles, the coating will be transitioned to the Low Rate Initial Production and Production of the AAAV. The paint system will be transitioned to the Fleet through specification modifications and revisions to the Marines technical manuals. If further development and/or field-testing is required, AAAV program funding or demonstration program funds will be pursued.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is continued effort in the defense and commercial industry to move away from the hexavalent chromium system. The successful development of the coating will permit the use of the coating on other ground, amphibious, sea, or air platforms, as well as the commercial industry, including automotive and others.

REFERENCES:
1. Advanced Amphibious Assault Website – www.aaav.usmc.mil

2. MIL-DTL-64159 – Coating, Water Dispersible Aliphatic Polyurethane, Chemical Agent Resistant;

3. MIL-PRF-23377 – Primer Coatings: Epoxy, High-Solids

4. MIL-PRF-85582 - Primer Coatings: Epoxy, Waterborne

5. MIL-P-53030 – Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free

6. MIL-P- 553022 – Primer, Epoxy Coating, Corrosion Inhibiting, Lead and Chromate Free

7. MIL-C-81706/5541 – Chemical Conversion Materials For Coating Aluminum and Aluminum Alloys / Chemical Conversion Coatings on Aluminum Alloy

8. AMS 2473 – Chemical Film Treatment for Aluminum Alloys

9. MIL-PRF-85285D –Coatings: Polyurethane, Aircraft and Support Equipment

KEYWORDS: primer; coating; corrosion, non-hexavalent chromium; hexavalent chromium; trivalent chromium, 2519 aluminum alloy, reduced or zero VOC

N03-162 TITLE: Non-Woven Textile Technologies

TECHNOLOGY AREAS: Materials/Processes, Human Systems

ACQUISITION PROGRAM: ACAT IV: PM Infantry Combat Equipment, ICE

OBJECTIVE: The primary goal of this initiative is to use non-woven fabric technology to increase performance and reduce lifecycle costs of combat clothing and equipment.

DESCRIPTON / BACKGROUND: While textile technologies have made significant improvements in recent years, the capability of the U.S. Industry to develop and compete new technologies and manufacturing processes has decreased. Only a handful of manufacturers currently exist. The majority of military clothing and equipage items currently use woven fabric and some knit technology. Non-wovens appear largely as a base for fusible applications. However, non-woven fabrics can be used to reduce labor and manufacturing time while improving durability and comfort at a cost savings. Also non-wovens could provide additional competition for the military to acquire base fabrics for either field launderable clothing (Battle-Dress-Uniforms, Rainsuits, Chemical Protective Uniforms, etc) and equipage (backpacks, tentage, duffle-bags, sandbags, sleeping bags, etc.) applications and aid in fabrication of end-items through use of ultrasonics or other stitchless technologies. This SBIR will investigate unique non-woven materials or processes relative to their expected end-item application with increased performance properties and will transition into the manufacturing of garments/equipage items for use across the wide spectrum of environments in which Operating Forces are expected to perform.

PHASE I: Compare the technical merit of non-woven materials with the performance of current materials to include durability, air-permeability, chemical (CP), flame (FR), water-proofness (WP) and thermal resistance (TR) properties along with the capability for non-wovens to be dyed, printed and finished. Applications would include unique fiber blends and processes for non-woven production. Included may be State-of-the-Art spraying process that could lay fibers onto Three-Dimensional end-item mold to produce end-items using non-woven slurry. Base fabric guidelines for clothing fabric would be expected to possess a max. weight of 7 oz / square yard per American Society for Testing and Materials, (ASTM) D-3776, 5 lb min. tear strength per ASTM D-5734, 80 lb min Breaking Strength per ASTM D-5034, min. of 50 cu ft/

min/sq. ft. air permeability per ASTM 737. Also required would be soft hand and suppleness of resultant non-woven product for clothing application along with consideration of durability, launderability, abrasion resistance and other factors related to specific end-item application, i.e. Chemical Suits shall possess (CP), tentage shall possess FR & WP, rainsuits WP etc. Conduct limited laboratory testing to validate research in this area relative to end-item use. Identify materials with properties worth investigating in Phase II fly-off.

PHASE II: Produce enough of the selected materials identified in Phase I to conduct developmental testing and fabricate clothing / equipage end-items designed for each non-woven development. Material properties should be verified on swatches before producing clothing or equipment. Manufacturing issues will be documented to include fabric production, camouflage printing, seams, sewing or stitchless processes. All environmental type end-items shall have leak-proof seams. Prototype garments shall be produced for field evaluation. The results of the research, developmental testing and field evaluation will be documented in a technical report with conclusions on the utility of non-woven fabrics for various military applications.

PHASE III: Non-Woven Textiles have applications to both military and civilian markets. Develop a Marketing Plan to develop a large enough consumer base to bring production cost down along with Web-Site denoting relationship between base non-woven structures combined with all related properties (FR, WP, CP, TR, etc) and end-item assembly processes.

COMMERCIAL POTENTIAL: This material and the garments produced have application across a wide spectrum of commercial environments including outdoor recreation (hunting, fishing, camping), sleeping bags, low cost rainsuits, temporary shelters, backpacks, etc.

REFERENCES: American Society for Testing and Materials, Vol. 07.01 and 07.02.

KEYWORDS: Non-Woven Fabric, Thermal Resistance, Permeability, and Flame Resistance

N03-163 TITLE: Remote Non-Contact Personnel Incapacitation System

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: ACAT IV: Infantry Weapons Systems

OBJECTIVE: The Marine Corps needs a non-contact, non-chemical, non-lethal, non-permanent capability to temporarily incapacitate (render ineffective) personnel as point or area targets.

DESCRIPTION: This topic seeks an incapacitation capability to temporarily incapacitate people with directed energy. The system must cause no permanent or scaring injury throughout the entire 0-100 meter range. The energy delivered can be optical, electromagnetic, acoustic, or a combination of energies etc. provided that there is no physical contact with the target. The temporary incapacitation effect can cause a person to be temporarily unable to control their muscles, specific muscles, specific nerves (optic nerve, auditory nerve, vestibular nerve etc.) or even render them unconscious. The effect must last no more than 24 hours and produce no permanent effect. It is required that the system works in the open in the 0-100 meter range or more. If a minimum safety stand-off distance is required, it should be no more than 10 meters. Additionally, it is desired for the system to operate through materials like walls or non-metallic barricades if possible. Current technology for this is limited to Taser (Electro-Muscular Disruption) type systems that deliver an electric shock with a peculiar pulse characteristic and power through a pair of electrical wires that disrupts or overpowers the transmission of signals from the brain to the muscles. Also laser systems are available that temporarily dazzle the targeted person. The desired system should operate without wires and also affect personnel that are not looking at the system used.

PHASE I: Demonstrate insofar as possible the scientific, technical, and commercial merit and feasibility of the idea submitted, by producing a system design, and analysis to predict expected performance. Implement the technology with a brassboard model of the critical components that demonstrates the applicability and indicates the safety and effectiveness of the proposed system. Provide a report on the capabilities based on cost, schedule, technical performance and risk.

PHASE II: Build a prototype of the system proposed in Phase I. The prototype shall be produced to best commercial practices. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant system shall be made commercially available by the close of Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Military and law enforcement organizations have a need to render unconscious or otherwise prevent or control action on the part of personnel from a 0-100 meter range. Systems that do not produce physical contact eliminate the eye hazard of darts or other impact injuries.

REFERENCES:

1. Joint Non-Lethal Mission Area Analysis
2. Mission Need Statement for Military Operations in Urban Terrain (MOUT)

KEYWORDS: Incapacitation, Non-Lethal, Urban Operations, Neurological Disruptor, Directed Energy

N03-164 TITLE: Multi-Band Air Defense/Air Search Radar

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Battlespace Management & Air Defense Systems (BMADS Radar Systems)

OBJECTIVE: Enable radars to operate in more than one frequency band so they can perform each of multiple functions, such as air surveillance and target cueing, in the optimum band.

DESCRIPTION: L- and S-Bands are typically considered the best frequency ranges for acquisition applications and X-Band best for tracking. Modern radars attempt to be multi-role, so C-Band provides a compromise, but C-Band's spectrum is very restricted for military use in the USA. Since no single radar band possesses characteristics that provide optimal performance, it would be useful to operate in more than one frequency band, but current antennas and components are not designed for multi-band operation. Processing can currently be accomplished over a wide frequency range, but novel antenna designs are needed for multi-band applications. The Marine Corps currently has FY04 funding to begin System Integration of the Multi-Role Radar System (MRRS) in FY05. The MRRS requires an antenna array that will fit within the size and weight constraints of a HMMWV and be transportable on a C-130 aircraft. It is assumed that the antenna will be a modern phased array antenna. Currently Army CECOM is studying an S-Band only approach to multi-role radar under the Multi-Mission Radar program, and the Marine Corps, under Office of Naval Research, is studying an X-Band approach under the Affordable Ground Based Radar program. Since the development of an antenna is beyond the SBIR expected funding limits, this SBIR effort is limited to developing dual band Transmit/Receive (T/R) modules and proposing a layout of the modules as they would be on an antenna, but NOT include an antenna design.

PHASE I: During this phase, an engineering analysis will produce various approaches. Transmit/Receive modules must operate in two or more bands: one of these bands must be in L or S, and the other band must be C or X (possible combinations for a dual band design are: L/C, L/X, S/C or S/X). Approaches will be compared for engineering feasibility. Based on this comparison, a system concept will be developed in a system specification based on the best approach. A method to prove this concept will be presented to include the factors of producibility, cost and system performance. Characteristics of a prototype will be identified to include size, weight, and power consumption. Areas of risk will also be identified.

PHASE II: Develop and test the multi-band modules. Module will meet the following specifications.
Multi-Band T/R Module Specs per Band;
Gain(dB) Rcvr L:>25, S:>25, C:>25, X:>25

IPT3in (dBm) L:>5, S:>5, C:>5, X:>5
NF (dB) includes cirulator loss L:<2.5, S:<3.0, C:<3.5, X:<4.0
Phase Control Bits L:6, S:6, C:6, X:6
Attenuation Control dB L:30,S:30, C:30, X:30
Bits L:6, S:6, C:6, X:6-7
Transmitted Power Peak L:>200, S:>50, C:>30, X:>10
Average (Watts) L:>20, S:>12.5, C:>7.5, X:>2.5
PAE L:>45%, S:>40%, C:>40%, X:>35%
Input/Output VSWR L:1.5:1 mas, S:1.5:1 max, C:1.5:1max, X:1.5:1 max; Rcvr Limiter CWpower without damage to LNA L:4 x Xmit PeakPower, S:4 x Xmit Peak Power, C:4 x Xmit Peak Power, X:4 x Xmit Peak Power
(Note: Peak Junction Temperatures Given 50 C Module Case Temperature <150C or GaAs, and <100-125C for SI).

Produce enough modules to verify the proof of concept developed in the first phase, but not fewer than two modules. A detailed specification and drawings will define the design. System performance will be verified in accordance with Section 4 of the specification. A module layout will be provided.

PHASE III: Successful technology developed by the small business would be transitioned to one or more radars being considered by the military services. In the Marine Corps this would include the MRRS and/or the Highly Expeditionary Long Range Air Surveillance Radar (HELRASR).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be used anywhere that currently requires more than one radar system to perform its mission. An example is airports that have separate airport surveillance radar and precision approach radars.

REFERENCES: Characteristics of various radar bands may be found in standard radar texts such as Merrill I. Skolnik's Radar Handbook, 2nd ed., New York: McGraw-Hill, 1990.
Information on the Army's Multi-Mission Radar may be obtained from the project officer, Mr. Paul Yao, at (732) 427-6524.

KEYWORDS: Multi-Band; antennas; Transmit/Receive modules; radar; adaptive arrays

N03-165 TITLE: Reduction of Ground Vehicle Observables

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT ID: Advanced Amphibious Assault Vehicle (AAAV)

OBJECTIVE: Reduce the vulnerability of ground vehicles to detection and weapon-targeting systems.

DESCRIPTION: The Marine Corps Advanced Amphibious Assault Vehicle (AAAV) is a 76,000 pound armored vehicle designed to operate over harsh off-road terrain and in oceans and rivers. The AAAV is expected to operate in severe environments such as high humidity, seawater, sand, mud, rocks, gravel, etc. and must be capable of withstanding severe impact and abrasion loads from rock and debris while moving at high speed (45 mph) over rough cross country terrain. Climatic conditions can range from ¡V65„aF to +125„aF.

All self-propelled vehicles, including ground vehicles produce observable signals. These signals may be acoustic, visual, infrared, electromagnetic, ground vibration, and the like that are detectable by an adversary¡¦s sensor systems. Any reduction in such emissions can help our forces maintain the element of surprise in maneuver warfare and reduce the vulnerability of our forces to counterattack. The AAAV Program is particularly interested in reducing the detectable signals from diesel engine exhaust. Some detectable signals the AAAV program would like to reduce from diesel exhaust are noise, heat, and gas particulate matter trace components. Components proposed to reduce observables shall minimize weight, space and power consumption. A reduction in observables shall not be at the expense of vehicle speed or troop-carrying capacity.

PHASE I: Evaluate candidate concepts for reducing engine observables. Present trade-offs of performance capability as a function of cost, weight, space and vehicle integration impact.

PHASE II: Prepare and demonstrate proof-of-concept test article(s). Perform measurements, gather data and analyze results to support that proof-of-concept will successfully reduce one or more AAAV engine observables. Following successful proof-of-concept testing, conduct engine acoustic, thermal, and/or particulate emissions testing on a tactical vehicle (preferably a AAAV). Perform measurements, gather data and analyze results to support proof of reduced engine observable(s).

PHASE III: Demonstrate producibility of systems. Transition and integrate into full-scale vehicle production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Reductions of soot and noise from diesel and gas-turbine engines are of substantial value in commercial vehicles.

REFERENCES:
1. Advanced Amphibious Assault Website ¡V www.aaav.usmc.mil
2. Diesel Emissions Technology, Society of Automotive Engineers, ISBN 0-7680-0790-9; Diesel Exhaust Aftertreatment, Society of Automotive Engineers, ISBN 0-7680-0547-7

KEYWORDS: engine emissions; detectability; vulnerability reduction; vehicle observables; soot reduction; exhaust modulation

N03-166 TITLE: Remote Perimeter Security System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Infantry Weapons Systems

OBJECTIVE: The Marine Corps needs an integrated autonomous video/audio perimeter security capability for a 360o perimeter able to view to a minimum of 300 meters and automatically distinguish whether the intrusion is a human or an animal.

DESCRIPTION: This topic seeks a perimeter security system or system of systems that will provide a capability of automatic/autonomous Infra-red, ultra-violet or daylight video pattern detection/recognition/identification with an audio capability to eaves drop on intent of persons detected. The system must be able to view/identify to a minimum of 300 meters or more. It is required that the system detect and provide a threat alarm in the open with the target potentially camouflaged in a tree line at 300 meters as well as in an urban environment i.e. embassy. The system must be effective 24 hours per day. The proposed concept should focus on technologies that enhance an existing system. Existing cameras are available but they have either a 100 meter maximum range or a $750,000 price tag. We are looking for technology that will allow 4 cameras at a maximum cost that is less than $150,000 for the system.

PHASE I: Demonstrate insofar as possible the scientific, technical, and commercial merit and feasibility of the idea submitted, by producing a system design, and analysis to predict expected performance. Implement the technology with a brassboard model of the critical components that demonstrates the applicability and indicates the effectiveness of the proposed system. Provide a report on the capabilities based on cost, schedule, technical performance and risk.

PHASE II: Build a prototype of the system proposed in Phase I. The prototype shall be produced to best commercial practices. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant system shall be made commercially available by the close of Phase III.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Military and law enforcement organizations have a need to detect/recognize/identify persons at a distance and also to be able to determine their intent. There is also a potential for the home/commercial security market.

REFERENCES:
1. Joint Non-Lethal Mission Area Analysis
2. Statement of Need (SON) for a Sensor Device (SD)

KEYWORDS: Audio/Video, Non-Lethal, Urban Operations, Perimeter Security, Sensor, Directed Energy

N03-167 TITLE: <u>Low Cost High Strength High Toughness Corrosion Resistant Materials for Marine Corps Advanced Amphibious Assault Vehicle (AAAV)</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: ACAT IV: Advanced Amphibious Assault Vehicle

OBJECTIVE: Reduce material costs while maintaining corrosion resistance and improving load carrying capacity.

DESCRIPTION: The Marine Corps AAAV is a 76,000 pound armored vehicle designed to operate over harsh off-road terrain and in oceans and rivers. The AAAV is expected to operate in severe environments such as high humidity, seawater, sand, mud, rocks, gravel, etc. and must be capable of withstanding severe impact and abrasion loads from rock and debris while moving at high speed (45 mph) over rough cross country terrain. Climatic conditions can range from –65°F to +125°F.

During AAAV development, one of the Marine Corps primary concerns is controlling costs. The Marine Corps is looking for lower cost material solutions to titanium in order to reduce overall vehicle costs while maintaining or improving load carrying capacity. Potential material solutions could include metal foams, ceramics, composites (including nanocomposites), developmental alloys, etc. The material system may also include an innovative shape or form that increases load carrying capacity, impact resistence, and fatigue strength. The material solutions considered should possess high strength and toughness, impact resistance, and good corrosion resistance in marine applications. Desireable properties would be tensile ultimate 220 KSI, tensile yield 200 KSI, elongation 15 per cent, combined with superior fatigue, fracture toughness, impact resistance, corrosion fatigue and stress corrosion cracking resistance. Corrosion resistance should match or exceed the performance of the commonly utilized stainless steels for marine applications. Any material chosen should have a valid database that would satisfy at least MIL-HDBK-5 'S' basis as a minimum. A certification will be required. The AAAV uses a significant amount of titanium, Ti-6-4, primarily in the form of forgings, which provides good corrosion resistance at a reasonable weight. The use of Ti-6-4 has resulted in greatly increased raw material and machining costs. By substituting a lower cost, high strength-high toughness, and corrosion resistant material solution, that may also offer easier machining characteristics, overall vehicle costs are expected to be reduced, with the potential for weight reduction. One potential candidate for a material change is the Hydro-pneumatic Suspension Unit (HSU). HSU is the AAAV's number one cost driver because it is primarily made of titanium (Ti-6-4). The HSU arm body, currently a Ti-6-4 forging, may be used as a benchmark, for the comparison matrix between material candidates through design/weight/structural optimization. HSU performs the same function as the roadarms typically used in armored vehicle suspension systems, except that they are made of titanium and charged with nitrogen gas to create a spring force. There are 14 HSUs on each vehicle and they are highly loaded since they carry the entire weight of the 76,000 pound AAAV. The Marine Corps would like to consider alternative material solutions to reduce HSU machining and raw material costs without degrading corrosion resistance, weight, and load carrying capacity and other performance requirements. On the proposed material solution, other candidate components can be selected during the

Phase I effort.

PHASE I: Investigate advanced material solutions, processes, and design concepts to meet the above objective. Trade off studies will be carried out to evaluate cost, weight, durability, and expected performance. Material and corrosion laboratory testing will be conducted to insure that the selected materials' properties meet component design requirements. Develop preliminary design concepts suitable for Phase II prototype development. Submit a final report and present trade study results and the preliminary design concepts. The materials and processes selected must comply with environmental regulations and requirements and must avoid AAAV Program mandated hazardous materials.

PHASE II: Complete the preliminary design, to include prototype and production cost estimates, stress analysis, and detailed drawing development suitable for manufacturing. Fabricate limited quantities of selected components for lab testing. This will include tensile, fatigue, hardness, fracture toughness, impact, and corrosion testing. General, stress corrosion, and fatigue corrosion testing, based on the material solution selected, may be required. Once the laboratory testing is complete and the design is updated, fabricate additional components for on-vehicle testing. The prototype components will be placed on an AAAV and field tested for a minimum of 3,000 miles or until failure. During testing, the contractor will provide test support in the form of a point of contact for technical information, maintenance, test plan development, failure analysis, etc. On-vehicle testing will be funded and carried out by the AAAV Program Office, however, the contractor will visit the test site in order to evaluate performance and failures. The contractor will submit a final report containing all relevant design data and other documentation related to the components under test.

PHASE III: Demonstrate producibility of the components and develop a transition and implementation plan for AAAV production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Can be used where durable, corrosion resistant, and relatively low cost materials are needed in place of titanium. Commercial applications include marine and offshore equipment.

REFERENCES:
1. Advanced Amphibious Assault Website – www.aaav.usmc.mil

2. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22

3. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189

4. MIL-STD-810F, Environmental Engineering Considerations And Laboratory Tests
Keywords: HSU, hydropneumatic, titanium, durability, producibility, affordability, lightweight, advanced materials and processes, reinforcement, hazardous materials

KEYWORDS: material systems, metal foams, composites, nano-composites, developmental alloys

N03-168 TITLE: <u>Innovative and Scalable Manufacturing Process for Aerospace Grade Titanium Casting</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop an innovative and scalable manufacturing process for making the aerospace grade Ti-6Al-4V casting used in the naval aircraft.

DESCRIPTION: Investment casting is the current preferred approach for producing aerospace grade Ti-6Al-4V castings for current military aircraft systems. However, the quality of titanium castings strongly depends on a number of factors including preventing the introduction of ceramic inclusions into the castings during the shell building process, formation of hard alpha particles during solidification, need for weld repair/rework operations, and variation in grain size/distribution in thick titanium parts. In addition, the process requires many pre-article trial-and-error runs, and can be labor-intensive and costly.

The U.S. Navy is interested in developing an innovative and scalable manufacturing process for fabricating aerospace grade Ti-6Al-4V casting. In particular, the process of interest should either improve the investment casting process or develop a new approach to replace the existing process. Resultant castings should be qualified for microstructure and mechanical properties (at various locations within the casting), surface finish, and part geometrical complexity. Furthermore, cost reductions as compared with the existing process are expected to allow more aerospace applications using structural titanium castings.

PHASE I: Provide an initial development effort that demonstrates scientific merit and feasibility of the proposed manufacturing process for making the aerospace grade Ti-6Al-4V castings. Samples should be fabricated and characterized micro-structurally (at various locations within the casting), and fatigue tested for their durability. These castings should also demonstrate a complete removal of alpha case with surface finish achieving 125 rms or better. The oxygen content of the as-produced castings should be less than 0.2%. These samples also need to demonstrate the capabilities of the process in terms of geometrical complexity and potential scalability, and a reduced level of repair/rework operations. Nondestructive detection method should be selected and evaluated for the detectability of foreign particles and defects in the castings up to 3 inches in thickness.

PHASE II: Fabricate and characterize full-scale prototype castings based on the Phase I SBIR effort. In this phase, the contractor is expected to work with the aircraft manufacturers to select the candidate components for testing, and to develop the process for production readiness. A nondestructive detection method should be selected and evaluated for the detectability of inclusions and defects in the castings.

PHASE III: Produce and qualify (with Navy personnel) structural titanium castings and transition to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Successful development of this innovative and scalable manufacturing process can increase the yield and reduce the acquisition cost of structural Ti-6Al-4V castings for both commercial aircraft as well as military aircraft. More widespread usage of structural titanium castings is expected for the aerospace industry.

REFERENCES:
1. S. Veeck, et. al, "Titanium Investment Casting," Advanced Materials & Processes, January issue, pp. 59-62, 2002
2. SAE Standard, AMS 4985, Titanium Alloy, Investment Castings, Ti-6Al-4V

KEYWORDS: Titanium Castings; Investment Casting; Fatigue Property; Microstructure; Manufacturing Process; Naval Aircraft

N03-169 TITLE: Incorporation of Analysis Enhancements of a p-Element Analysis Code Required for Implementing the Strain Invariant Failure Theory

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO-T: ACAT IC

OBJECTIVE: Develop p-element based handbook finite element code that feature laminated general shell elements, contact elements, and general curvature material descriptions to facilitate the strain invariant failure analysis of composite structure.

DESCRIPTION: Historically, the correlation between predicted failure and actual failure of structures comprised of composite materials has left much to be desired. The over or under prediction of failure load often exceeds 25%, with the failure location being completely missed. This inability to accurately model and predict composite structure has led to a lengthy, costly, test based certification process.

Industry has been assessing one of the promising failure theories for composites, the Strain Invariant Failure Theory (SIFT), that is proving to be more accurate at predicting failure locations and load levels in a variety of structural composite material forms, including woven pre-forms. This theory shows promise for streamlining composite structural design and establishing a path for certification-by-analysis. See references for a description of SIFT.

In order for this failure theory to see widespread acceptance, it must be implemented into an efficient analysis package and become user friendly. P-element based analysis has been shown to be extremely efficient for critical structural analysis problems. Development of a handbook based p-element code for SIFT, baselined with F-18 control surface specific composite geometry, would allow for different composite geometries to be modeled effectively and quickly, with accurate failure predictions. There are two main types of composite structure of interest: 1) Discrete composite substructure, such as I's, C's and J's, cocured/cobonded to composite skins with compound curvatures and 2) Bolted joints consisting of either composite substructure bolted to composite skins or metal substructure bolted to composite skins.

PHASE I: Demonstrate feasibility of incorporating the following features, which are required for SIFT analysis, into a p-version finite element code:

1) General shell p-elements, with laminated capabilities, and transition elements, which will allow for improved global/local analysis, with solid p-elements, entirely within the code.

2) Definition of laminated orthotropic material properties that follow the curvature of shell and solid p-elements for single ply and sublaminate property assignments.

3) Contact p-elements and 3D fastener p-elements with interference fit and clamp up capabilities.

PHASE II: Complete Phase I algorithim development and incorporate into p-element code. Demonstrate the validity of the code through application to F-18 composite structural problems. Develop a p-element automesher applicable to laminated composite structure.

PHASE III: Transition the developed analysis package to military and commercial airframe manufacturers as well as department of defense laboratories. The analysis package will enable efficient and accurate design of composite structures.

COMMERCIAL POTENTIAL: A user-friendly p-element code that utilizes SIFT as its failure theory could be used by the commercial aircraft market to increase their use of composite materials. The developed analysis package could be utilized by the automotive and boating industry in the design and analysis of high performance cars and boats.

REFERENCES:
1. Gosse, J., "Strain Invariant Failure Criteria for Fiber Reinforced Polymeric Composite Materials," Proc. 13th Int'l Conf. on Composite Mat'ls, Beijing, China, 2001.
2. Gosse, J., and Christensen, S., "Strain Invariant Failure Criteria for Polymers in Composite Materials," Proc. 42nd Struct. Dyn. & Mat'ls Conf, Paper AIAA-2001-1184, March 2001, pp 45-55.
3. Tsai, H., Alper, J., Barrett, D., "Failure Analysis of Composite Bonded Joints," Paper AIAA-2000-1428.

KEYWORDS: Strain Invariant Failure Theory (SIFT); F-18; Composite Materials; p-Element; Handbooks; Finite Element

N03-170 TITLE: Protective Conformal Coating System (Non-Chromate) for Aircraft Radar Systems

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop a non-chromate protective conformal coating system for use on the radiators and cross polarization (x-pol) load of aircraft radar antenna systems.

DESCRIPTION: The x-pol load is a metal oxide-loaded polyurethane, subsequently coated with a polyurethane conformal coating for corrosion protection. The x-pols are installed between array radiator elements to absorb enemy radar signals.

Navy aircraft operate in a very corrosive environment. Corrosion of radar components leads to performance loss. Currently, the Navy aircraft finishing systems for radar equipment do not contain corrosion inhibitors. The new coating should be a single coat system that does not require a primer and/or a topcoat. It should provide corrosion protection while not adversely reducing the radar signal, transmission or performance characteristics, especially the dielectric constant. The technology shall meet the electrical performance requirements of MIL-I-46058 and the corrosion requirements of TT-P-2756. Experience has shown that any coating that contains trace amounts of metallic contaminants will reduce the performance of the radar system. The base material of the radiators is an aluminum alloy. Increased awareness of and concern about environmental issues has identified the elimination of chromates and the reduction of both volatile organic compounds (VOC's) and hazardous air pollutant (HAP) emissions in the development of all new coating systems. The majority of chromate containing compounds has been identified as human carcinogens. The Navy desires the development of an environmentally friendly coating system.

PHASE I: Determine the feasibility of producing a corrosion prevention coating for application on radar systems. The coating must meet the current military and performance specifications as well as be compatible with existing materials. The proposed coating shall not reduce or degrade the radar signal/performance. In addition the application of the coating should not interfere with the logistical and operational requirements of the naval facility tasked to use the new coating.

PHASE II: Further develop the coating to meet the objectives of the Phase I results and conduct laboratory testing to further characterize the properties and performance of the technology. Successfully prove the performance of the coating in field demonstrations.

PHASE III: Produce the coating and transition it to the Fleet. Perform further development and/or field testing as required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be transitioned to commercial aircraft as well as non-aerospace applications for both the government and private sectors.

REFERENCES:
1. MIL-I-46058, Military Specification, Insulating Compound, Electrical
2. TT-P-2756, Federal Specification, Polyurethane Coating: Self-Priming Topcoat, Low Volatile Organic Compound (VOC) Content

KEYWORDS: Coating System; Primer; Top Coat; Radar; Environmentally Friendly; Non-Chromate

N03-171 TITLE: Very Low Volatile Organic Compound (VOC) Spray Application Process for Iron Filled Elastomeric (IFE) Coatings

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop spray application equipment capable of applying very low VOC Iron Filled Elastomeric (IFE) coatings.

DESCRIPTION: The Navy and the Air Force currently use IFE or magnetic random access memory (MagRAM) coatings in low observable (LO) survivability design. Spray application is the primary application method due to the extensive variations in substrate (outer mold line) composition, and shape. The conventional spray application method requires the use of a significant volume of solvent, necessary to promote fluid flow and atomization during spraying. Such extensive use of a VOC-containing solvent during product manufacture presents significant health and air quality hazards and impairs process throughput and product quality. The solvents typically used, such as methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK), also present ever-increasing EPA and local air quality challenges to reduce or eliminate their use.

With the aggressive production rates proposed for the JSF program, optimizing manufacturing throughput is of paramount concern. Solvent-filled MagRAM coating application processes are often necessarily positioned directly in the critical path, noticeably inhibiting process flow for peak efficiency. Typical problems encountered as a direct result of high VOC MagRAMs include protracted IFE thickness build rates, unacceptable post-application material shrinkage, and unpredictable material performance evaluation. Ensuring product quality requires delaying the manufacturing flow due to solvent evaporation and polymer cure. An Air Force led Environmental Security Technology Certification Program (ESTCP) (scale-up, demonstration and validation of environmentally advantaged RAM coatings) has recently been initiated to evaluate materials using high-volume low-pressure (HVLP) and plural component spray application equipment. However, the materials being tested still contain solvents, including exempt solvents, or use low-molecular-weight binder bases, which can adversely affect product quality. Ideally, the spray application process would effectively apply high viscosity, approximately 120 Kreb's units (KU), and IFE coatings containing minimal, less than 5 percent, solvents. The low VOC IFE application process is intended to greatly reduce health, environmental, product quality, and manufacturing throughput issues leading to significantly reduced product cost.

PHASE I: Demonstrate the feasibility of a spray application process capable of applying a 120-KU viscosity, 2.5-density IFE coating to a dry film thickness of 30 mils per coat.

PHASE II: Demonstrate the capability to meet weapon system performance and manufacturing constraints. Evaluate specific equipment design configurations based on required equipment integration constraints such as commercial robotic system design and anticipated environmental conditions within a production environment. Concurrently, produce and evaluate specific engineering test articles to determine system performance capabilities and limitations.

PHASE III: Develop the Phase II prototype into a usable product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private aircraft companies can use successful coating and equipment, other industries that use spray coating equipment, and other DoD aircraft programs.

REFERENCE:
1. ESTCP Program No. 03 E-PP#-003P proposal, posted under "new starts" on http://www.estcp.org/projects/pollution

KEYWORDS: MagRAM; Iron Filled Elastomer; Aircraft Coatings; Iron Filled Elastomeric; Low VOC; Zero VOC

N03-172 TITLE: Quick Cure Long-Shelf-Life Liquid Shim

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop a quick cure one-part liquid shim material with a minimum of one-year shelf life.

DESCRIPTION: The Navy and the Air Force currently use epoxy liquid shim materials for aircraft assembly. Two-part epoxy that is mixed just prior to application on the airframe components being assembled is the current standard method. However, this method is time consuming and excessive labor is required for application and clean up of excess liquid shim. This particular process has historically been a schedule driver on the F/A-18 E/F and is expected to impair aircraft throughput on the Joint Strike Fighter (JSF) program where rates are a magnitude greater than on F/A-18 E/F.

With the aggressive production rates proposed for the JSF program, optimizing manufacturing throughput is of paramount concern. Liquid shim application processes are often necessarily positioned directly in the critical path, noticeably inhibiting process flow for peak efficiency. Two-part liquid shim materials typically require eight hours or more prior to being able to perform the next assembly process, i.e., drilling. A liquid shim material is required that provides less than two hours cure while allowing adequate time for assembling the components. Frozen liquid shim materials provide quicker cure but have short work and shelf life and require additional freezer storage and logistical support. Innovative material approaches for creating a quick cure (less than two hours), long work life (greater than one hour), with greater than one-year shelf life at room temperature liquid shim is required to eliminate the liquid shim process from the critical assembly path.

PHASE I: Develop a feasibility concept for a one-part liquid shim material. Performance requirements include a greater than one-hour work life, less than two-hour cure time, and long shelf life. Preliminary testing should be done to demonstrate cure time, work life, and shelf life.

PHASE II: Modify, fabricate, and demonstrate the proposed material. Specific mechanical, physical, environmental, and process applicability will be evaluated based on production environment constraints. Concurrently, long-term shelf-life testing will be performed to demonstrate a minimum of one-year room temperature storage.

PHASE III: Develop the prototype into a commercial product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Successful quick cure, long work life, long room temperature storable liquid shim material can reduce manufacturing time and reduce labor hours for other industries where liquid shim material is used.

REFERENCE:
1. Society of Automotive Engineers, Aerospace Materials Specification, SAE-AMS3726, Shims, Filled Resin Compound Liquid

KEYWORDS: Liquid Shim; Quick Cure; Long Work Life; Room Temperature Storage; One Part Shim Material; Long Shelf Life

N03-173 TITLE: Video Data Compression

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-W: ACAT IC

OBJECTIVE: Develop image and video compression techniques that will significantly increase the transmission capability of current data links by providing greater compression ratios without additional degradation relative to current techniques.

DESCRIPTION: The timely collection and/or distribution of digital information are critical to modern warfighters operating in a system of systems environment. The capacity and speed of collection, storage, and distribution mechanisms continue to increase, but they still lag behind the demand for data. For example, a single Predator mission in Afghanistan requires more communication bandwidth than all of Operation Desert Storm. The advent of new collection systems and the potential of tying together multiple aircraft and aircraft sensors is further widening the gap. Conventional compression techniques, including those based on discrete cosine (JPEG/MPEG-2), wavelet, and fractal transform algorithms, cannot meet the current data transmission requirements and offer little potential for meeting future requirements. The Navy currently uses JPEG for still images and MPEG-2 for video images. The intent of this topic is to develop new techniques that exceed the performance of existing bandwidth compression techniques by a factor of approximately five to ten. In order to be considered, new techniques should not degrade data to be compressed further than current techniques. Likewise, the computational complexity of new techniques should not significantly exceed that of current techniques.

PHASE I: Define details of the new compression technique at a level sufficient to permit implementation in software during Phase II. Provide evidence for the technique's potential by estimating performance in terms of compression ratios relative to losses along with computational complexity. Demonstrate key mathematical techniques in software. Develop a plan for integrating the technique into a specific DoD system during Phase II.

PHASE II: Develop prototype software to implement the Phase I approach. Demonstrate the technique's performance using real data pertinent to the DoD system identified during Phase I. Use these results to develop a preliminary design for a deployable Phase III implementation, consisting of hardware and software as appropriate.

PHASE III: Transition the compression technique to a Navy program such as the Uninhabited Combat Air Vehicle (UCAV), Global Hawk, or JSF.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would significantly improve the performance of all military and commercial systems that rely on the collection and distribution of digital data. The biggest commercial application is the Internet, itself, which is currently choked with digital image and video data.

REFERENCES:

1. ISO/IEC 13818-1:2000, "Information technology – Generic coding of moving pictures and associated audio information: Systems", International Organization for Standardization, ISO/IEC JTC1/SC29/WG11, Coding of Moving Pictures and Audio.
2. Johnson, R. Colin. "JPEG 2000 wavelet compression spec approved," EE Times, December 29, 1999. http://www.eetimes.com/story/OEG19991228S0028.
3. JPEG 2000 Links to Information, http://www.jpeg.org/JPEG2000.html

KEYWORDS: Data Links; Compression; Networks; Battlespace; System of Systems; Sensors

N03-174 TITLE: <u>Multi-Sensor Terrain Fusion</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT IC: PEO-T

OBJECTIVE: Develop sensor data fusion and image registration techniques for the generation and maintenance of high-resolution terrain data over an operational area.

DESCRIPTION: Terrain data have long been used in various military applications such as navigation and determination of terrain masking. The primary source of terrain information has been digital terrain elevation data (DTED) produced by the National Imagery and Mapping Agency (NIMA). Most of the data produced to date have been rather coarse (DTED level I at 100-meter post spacing). However, recent developments have provided the opportunity to receive higher resolution data. The space shuttle conducted the “Shuttle Radar Topography Mission” (SRTM), which collected DTED level II (30-meter post spacing) over 80 percent of the Earth’s land mass. In addition, even higher resolution digital elevation models (DEMs) are being generated from various sources in support of applications requiring high precision such as battle space visualization, perspective scene generation, and precision terrain aided navigation (PTAN).

In an operational area, terrain data can be derived from multiple sources. First, NIMA can provide broad area coverage of DTED levels I and II, which can be used directly. In addition, NIMA also provides digital point-positioning data bases (DPPDB), which provide broad area optical stereo imagery to generate high-resolution DEMs. However, DPPDB may not cover all areas of concern and may not reflect the current tactical picture. Therefore, tactical and national sources have to be used to generate additional high-resolution DEMs. These sources can provide overlapping areas of coverage.

This effort should also examine the issues of automated change detection and how to automatically determine whether additional data will improve the accuracy of existing DEMs.

PHASE I: Identify and define innovative mathematical techniques for fusion of DEMs that are derived from varied sources and have overlapping coverage. Assess the feasibility of employing these techniques to automatically register and correlate sensor data as an on-going process of maintaining and updating a high-resolution tactical terrain database with no operator intervention. The formulation should be based upon an understanding of rigorous sensor models and basic sensor parameters that affect DEM accuracy and precision.

PHASE II: Develop, demonstrate and validate a prototype tactical terrain data base capability, which employs the proposed fusion techniques. Integration with government or commercial software packages and databases is highly recommended to demonstrate and validate the performance of fusion techniques with commonly used systems and data. Assess system throughput and estimate ability of the prototype to be effective with high volume data environments.

PHASE III: Fusion techniques, sensor parameter analysis, and processors will be integrated into a workstation in full operational condition.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that include agriculture, visibility, traffic, hydrographic analyses; imagery ortho-rectification, map production, and imagery visualization.

REFERENCES:

1. Rosen, P. A., Hensley, S., Joughin, I. R., Li, F. K., Madsen, S. N., Rodriguez, E., and Goldstein, R. M., "Synthetic Aperture Radar Interferometry," Proceedings of the IEEE, Vol. 88, No. 3, 2000, pp. 333-382.

2. Kweon, I. S., and Kanade, T. "High-Resolution Terrain Map from Multiple Sensor Data," IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 14, 1992, pp. 278-292.

3. Huber, D., and Hebert, M. "A New Approach to 3-D Terrain Mapping," Proceedings of the 1999 IEEE/RSJ International Conference on Intelligent Robotics and Systems (IROS '99), October 1999, pp. 1121-1127.

4. Fua, P. and Leclerc, Y. G. "Object-Centered Surface Reconstruction: Combining Multi-Image Stereo and Shading," International Journal of Computer Vision , Vol. 16, September 1995, pp. 35-56.

5. Reed, Michael and Allen, Peter. "Constraint-Based Sensor Planning for Scene Modeling," IEEE Transactions on Pattern Analysis and Machine Intelligence, December 2000.

KEYWORDS: Digital Elevation Models; Data Fusion; Precision Terrain Aided Navigation; Change

Detection; Shuttle Radar Topography Mission (SRTM); Terrain Extraction

N03-175 TITLE: Integrated Laser Electronics

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Integrate a laser optical subsystem with its ancillary power modulator and control electronics to reduce the size, weight, and cost of diode pumped solid-state lasers used in military applications.

DESCRIPTION: Conventional lasers used in military applications have discrete optical and electronic subsystems. The pump diode electronic circuit required significant volume and cooling within the overall laser system. This problem is particularly acute for quasi-continuous wave (CW) (pulsed) drive electronics. Designs and novel technology are sought to reduce the integrated size of the laser and its pulsed diode laser modulator. The power modulator must be capable of generating modulated waveforms, greater than 50 amps peak, designed for driving 808-nm diode pump laser bars. The modulation should be capable of 10s of Khz with a 20 percent duty cycle. It is also desired to tightly integrate the control and other ancillary electronics within the laser, such that additional space requirements are minimized. Design tradeoffs should optimize the overall cost of the opto-mechanical package and its associated electronics. The laser electronics and power modulator must be able to withstand tactical aircraft environments. Final sub-system weight, volume, efficiency, cost, and technological maturity are important considerations.

PHASE I: Determine feasibility, assess and demonstrate breadboard power modulator and control circuit designs traceable to an integrated design consistent with laser integration. Demonstrate that the electronics provide the required performance and functions in testing with a solid-state laser.

PHASE II: Develop a prototype to package and environmentally test the power modulator and control electronics. Electronics should be integrated with the diode pumped solid-state laser for end-to-end demonstration.

PHASE III: Transition the technology into a suitable system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Integrated laser power modulator and electronics may be used to reduce the size and cost of solid-state lasers used in many industrial, medical, and military applications.

REFERENCES:

1. Aviation Week and Space Technology, Article #20020107, 7 January 2002.

KEYWORDS: Laser; Electronics; Cost Reduction; Quasi-Continuous Wave (CW); Diode Laser Modulator; Opto-Mechanical

N03-176 TITLE: Optimized and Rapid Employment of Loitering Weapons in Response to Calls for Fire

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Weapons

ACQUISITION PROGRAM: ACAT III: PEO-W

OBJECTIVE: Devise an innovative method that optimizes the planning for and near real-time employment of loitering weapons and supports critical user decisions.

DESCRIPTION: The tactical Tomahawk weapon system introduces rudimentary planning capabilities for the loitering of the tactical Tomahawk missile, and two-way communications with in-flight missiles. This loitering capability enables the concept of stationing the missiles for rapid response to calls for fire from ground commanders. The initial planning capability, however, requires the user to select loiter patterns and areas with few aids relating to real, operational factors. Scenarios involving multiple missiles further complicate the decision making. The relevant operational factors include selecting operationally significant areas where targets are expected to emerge; minimizing response time to targets within those areas; observing emerging target trends within the areas; maintaining the capability to attack specific default targets; maintaining visibility of global positioning system (GPS) satellites; maximizing loiter time and survivability; avoiding friendly troops, threats to the missile, and keep-out zones and terrain (clobber); maintaining satellite communications with an abort capability for in-flight missiles; and reacting to emerging, time critical targets. The presentation of the factors involved in this problem, the tradeoffs made; and decision support for the user are additional challenges.

This SBIR topic seeks to advance the state-of-the-art in the mathematical optimization and decision support of complex problems that have a large number of variables while keeping the users in the loop by enhancing their situational awareness and allowing them to make tradeoffs in near-real time. To do so, the solution must: (a) optimally determine an initial loiter plan, (b) react to changes in the tactical situation over time with multiple missiles in loiter, (c) maintain user situational awareness, and (d) support near-real-time user decisions regarding in-flight missile assignments.

PHASE I: Develop an innovative concept for optimizing solutions to the loitering weapon problem, maintaining user situational awareness, and supporting near-real-time user decisions. Demonstrate the technical merit of the proposed solution.

PHASE II: Implement and demonstrate a prototype of the innovations developed in Phase I.

PHASE III: Mature the prototype capability for integration into the tactical Tomahawk weapon control system (TTWCS). Apply this approach to the Navy and Joint Services strike aircraft planning, and to the Army and Marine Corps precision attack missile (PAM) and the loiter attack missile (LAM). Apply the techniques developed in Phase II to commercial problems requiring optimized solutions to problems with a large number of variables.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Airplane transportation routing and scheduling, law enforcement patrol routing and emergency response management for crisis situations.

REFERENCES:

1. Guerlain, Dr. Stephanie. "The Tactical Tomahawk Weapons Control Interface Design Project," Department of Systems and Information Engineering, Human Computer Interface (HCI), University of Virginia and Naval Surface Warfare Center Dahlgren Division (NSWCDD). Article can also be found at http://www.sys.virginia.edu/hci/research.asp#military

2. Willis, Rob. "Effect of Display Design and Situation Complexity on Operator Performance", Department of Systems and Information Engineering, Human Computer Interface (HCI), University of Virginia. Article can also be found at http://www.sys.virginia.edu/hci/research.asp#military

KEYWORDS: Algorithm; Mathematical Optimization; Decision Support; Situational Awareness; Weapons Planning; Loitering Weapons

N03-177 TITLE: Innovative Aircraft/Ship Visual Landing Aid (VLA) Test Tool

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop an innovative analytic test tool that can be used to support vertical takeoff and landing (VTOL)/rotorcraft ship VLA analysis and testing at the test team member's work area.

DESCRIPTION: VLAs are required for night and/or low visibility aircraft/ship operations. The aircraft shipboard-landing scenario represents one of the most challenging technical areas of research and development under basic day visual meteorological conditions (VMC). At night, many of the pilot's day visual points of reference may not be visible. The pilot's perception of the ship VLA can be a function of the light type, location, orientation, intensity, color, and other factors like the flight deck area covered by the light, ship motion, distance from the ship and approach profile. Typical surface combatant ship's VLA lighting components include deck surface floods, superstructure floods, deck edge, drop line, line-up, extended line-up, overhead floods, deck status, stabilized glide slope, wave off, obstruction, navigation, stern maneuvering, mast maneuvering and homing beacon. The aircrew qualitatively evaluates how all the designated ship VLA components work together for all phases of the approach, landing, and takeoff maneuver for specified ship classes using qualitative visual landing aids rating scales. The cockpit external field-of-view of the ship flight deck area as the aircraft approaches the landing area should be available for test team members to view when working on proposed VLA configurations in their work area using personal computers prior to at-sea testing. The goal is to be able to fly specific aircraft shipboard approaches on a personal computer with a realistic view from the cockpit and to be able to adjust ship VLA components and environment lighting for both unaided and night vision device (NVD) aided operations. The illumination of the moon and stars could be provided with a PC-based light level-planning calendar. The advanced analytic VLA test support tool could also be tied into a comprehensive air vehicle flight test support tool to enhance dynamic interface test planning for night and/or low visibility test scenarios.

PHASE I: Determine technical merit of proposed innovative aircraft/ship VLA analytic test support tool to help night and/or low visibility dynamic interface testing. Address the VLA chromaticity requirements and the photometric characteristics of the individual ship lighting components. Include a plan to identify and model all the VLA test variables for specified aircraft operating aboard specified class ships.

PHASE II: Develop the innovative VLA test tool and demonstrate its ability to support an analytic VLA test using a specified aircraft/ship/VLA system. Demonstrate broad base use of the analytic tool by applying it to a VTOL and tiltrotor VLA test aboard an amphibious class ship. Also demonstrate application to a single rotor helicopter VLA test aboard a surface combatant type ship and aboard a Coast Guard Cutter class ship. Validate the VLA test tool against available test data. Demonstrate how the VLA test tool could be integrated with a comprehensive air vehicle model to support night and/or low visibility dynamic interface flight testing.

PHASE III: Use the analytic VLA test tool to support test requirements associated with new ship configurations like LHA(R) and DD(X).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The enhanced VLA test tool could be used to support future Coast Guard projects like the Deep Water Program and multi-service requirements. It could be used to support Military Sealift and commercial VLA tests and VTOL/rotorcraft land-based VLA testing.

REFERENCES:

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2. Smith, Anthony, “The Design of Visual Landing Aids for Shipborne Helicopters,” ASNE Day 2001, Washington, D.C., Apr. 2001.

3. SAE-AS25050, Colors, Aeronautical Lights and Lighting Equipment, General Requirements For, 13 Sep. 1999.

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May 1974.

KEYWORDS: Visual Landing Aids; Rotorcraft; VTOL; Test Tool; Ship; Night Testing

N03-178 TITLE: Built-In-Test (BIT) Fiber-Optic Transceiver Circuit

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop BIT circuitry for a fiber-optic receiver package (single-element and array), a cooled wavelength selected laser diode package, a fiber-optic link, and one or both of either an uncooled vertical cavity surface emitting laser (VCSEL) fiber-optic transmitter package (single-element and array); and/or a tunable laser diode transmitter package, suitable for operation in military/aerospace avionic network environments.

DESCRIPTION: Although some commercial sector optoelectronic packaging solutions contain limited circuitry for monitoring the health or status of fiber-optic transceivers and associated fiber-optic link circuitry, the circuitry that has been developed to date is inadequate for implementing BIT in avionic systems. For example, laser diode transmitter output optical power is sometimes monitored via a transmitter fault detection pin on the transmitter package, and receiver input optical power is sometimes monitored via a signal detect pin on the receiver package. In some cases, ancillary transceiver package pins are available for monitoring laser diode drive current and power, monitoring photodetector bias voltage and photocurrent, and driving and monitoring internal package thermoelectric coolers. However, no BIT interface circuits (electrical or optical and internal or external to the transceiver) have been developed for implementing BIT in avionic applications. The BIT circuit concept should be capable of differentiating between a fault in a transmitter package, a fault in a receiver package, and a fault in a fiber-optic cable linking the transmitter to the receiver.

PHASE I: Develop hardware and software concepts for implementing BIT circuitry for avionic fiber-optic transceivers and on-board fiber-optic cable plants. Demonstrate proof-of-concept optoelectronic/ microelectronic circuit designs capable of interfacing with fiber-optic receivers (both single-element and array) and cooled wavelength selected laser diode transmitter circuits, and one or both of either an uncooled VCSEL fiber-optic transmitter circuits (both single-element and arrays) and/or tunable laser diode transmitter circuits. The BIT circuit concepts should be applied to both digital (1 to 10 Gb/s) and analog (to 20 GHz) fiber-optic systems, including both fixed wavelength (i.e., 850 nm, 1300 nm, 1550 nm) and multiwavelength (i.e., wavelength division multiplexer (WDM)) systems.

PHASE II: Demonstrate BIT circuit hardware and software for both fixed-wavelength (i.e., 850 nm, 1300 nm, 1550 nm) and multiwavelength (i.e., WDM) avionic systems. The circuitry should monitor the output power of laser diode devices in fiber-optic transmitters (VCSELs and edge-emitting lasers), the wavelength of tunable and fixed-wavelength fiber-optic transmitters, and the sensitivity of fiber-optic receivers. Demonstrate logic and software to differentiate between faults in fiber-optic transmitters, fiber-optic receivers, and the fiber-optic cable plant linking the transmitter to the receiver. Demonstrate compatibility with typical military weapon replaceable assembly (WRA)/line replaceable unit/module (LRU/LRM) avionics box interfaces.

PHASE III: Transition BIT circuitry software technology to military/aerospace optoelectronic packaging and network interface and design. Incorporate the new BIT circuitry in avionic systems utilizing optoelectronic transmitters and receivers and fiber-optic interconnects (such as network interface cards, fiber channel network switches, and WDM networks).

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector applications include storage area networks, computer and telecommunication networks incorporating fiber-optic interconnects. The primary beneficiary of this technology development will be the optoelectronics industry. The secondary beneficiary of this technology will be the fiber-optic data communication network industry.

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4. Johnson, D. “Thermoelectric Coolers for Laser Diode Stabilization,” Marlow Industries, Dallas, TX.

5. Department of Defense Handbook for Maintainability of Avionic and Electronic Systems and Equipment, MIL-HDBK-2084. 1995.

6. Kelly, T., Baluta, H., and Monahos, T.J. “Computer-Aided Design for Built-In-Test (CADBIT),” Final Technical Report, RADC-TR-89-209, Vol. I, II and III, Rome Air Development Center, Griffiss Air Force Base, NY, 1989.

KEYWORDS: Built In Test; Avionics; Fiber-Optic Transmitter; Fiber-Optic Receiver; WDM; Fiber-Optic Cable Plant

N03-179 TITLE: <u>On-Board Real-Time Generator Component Failure Diagnostics</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT II

OBJECTIVE: Develop innovative methods to predict failure of critical E-2C generator components using real-time fiber optic sensory information in order to enable preventive maintenance without loss of useful generator life.

DESCRIPTION: The current E-2C fleet has been plagued by random generator failures of internal electrical components. The generator failures result in mission aborts, with occasional aircraft electrical failures and disintegrating mechanical components damaging the airframe and departing the aircraft in flight. Instrument meteorological conditions (IMC) flight safety risk correspondingly increases with a generator failure mandating the flight crew land as soon as practicable. Inspection, repair, and overhaul of the generator critical components are also costly and time consuming. The goal is to develop an embedded fiber optic (FO) intelligent system capable of automatically identifying specific generator component problems and predicting failure, which will result in a significant reduction of the flight safety risk and maintenance costs.

PHASE I: Determine feasibility of identifying and demonstrate measurement of critical electrical or mechanical component characteristics, indicative of failure, which can be implemented and monitored real time during generator operation in flight. Correlate with prognostic architecture capable of real-time prediction of remaining life.

PHASE II: Build a prototype smart sensor subsystem that can diagnose specific generator component failure modes and predict remaining life. Integrate the subsystem with an aircraft distribution network on a test bed.

PHASE III: Mature the prototype design into an air worthy system ready for Navy-wide and commercial implementation and deployment. Install and test the smart sensor system in an E-2C. Evaluate the effectiveness of the smart system failure predictions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Diagnostic and prognostic technology has broad application in the aerospace industry.

KEYWORDS: Fiber Optic; Sensors; Electrical Generators; Failure Predictions; Prognostic; Diagnostic

N03-180 TITLE: Automated Measurement/Alignment of Immersive Visual Displays

TECHNOLOGY AREAS: Information Systems, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Figher

OBJECTIVE: Automate testing of immersive visual systems using state-of-the-art technology. Provide measurement feedback to the display system and create an automated self-alignment/calibration interactive process.

DESCRIPTION: Extensive testing of very large field of view (FOV) displays used in training simulators is required in order to achieve full fidelity capability from the display system as well as to verify that performance is in compliance with requirements. This includes visual measurements in hundreds of directions especially across adjacent channel boundaries where quality is almost never ideal. Automated testing will result in more comprehensive testing and therefore better display systems. Time consuming testing of systems is performed on site to verify compliance throughout the FOV and throughout the viewing volume. However, automated test equipment is not available to quickly perform the many measurements for collimated and wide FOV immersive visual displays. A test instrument is required that systematically measures several parameters in precisely known directions throughout the FOV and from known locations within the viewing volume. The data must be automatically recorded and converted to meaningful plots. Also the device must be able to compute numerous specification parameters based on readings of various displayed test images. Topographical style aitoff plots (or equivalent) of numerous parameters is required including luminance, FOV, night scene black level, day scene brightness level contrast, resolution (horizontal, vertical, diagonal as well as spot size), color convergence, sub-regional luminance blemishes, absolute geometric distortion, and relative geometric distortion. Special attention will be paid to measuring parameters across blending regions between two channels. Additional desired parameters include color saturation, flicker, proportional levels of brightness, divergence, collimation, and accommodation. As an example of the type of tester possible, commercial off the shelf (COTS) components such as a photometric camera mounted on a displacement table mounted on an amateur telescope drive could be integrated with appropriate software written.

An automated method to adjust the display system based on interactive feedback from the test instrument is also required in order to obtain maximum fidelity possible from the display system. The automated alignment/calibration process needs to be performed at acceptance testing of new immersive display systems, after projectors or lamps are replaced, during routine scheduled maintenance in order to maintain the simulated system at optimum performance.

PHASE I: Demonstrate the feasibility of the proposed system to identify parameters to be measured/computed; analyze system performance, including user friendliness and time to perform measurements; establish level of accuracy; evaluate software and integration requirements; identify interface issues; and define plots to be generated based on interactions with the government.

PHASE II: Develop a fully functional prototype and perform an automated alignment/calibration of an actual training simulator using the tester.

PHASE III: Incorporate into the training simulator program used during Phase II. Transition to COTS tester and to automated calibration tool/component usable by any immersive display system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Testing all electro-optical display systems. Testing large FOV display systems and all collimated display systems especially commercial flight trainers. System can be incorporated into an automated calibrating/aligning display system. System can be used as a front end visual receiver/interpreter for an automated self calibrating display system which make adjustments to gamma, geometric distortions, etc. System can be adapted to become a recording instrument of high-resolution hemispheric FOV immersive images with laser distance ranging (required for database creation). Follow on designs include a Helmet Mounted Display tester using identical software and similar techniques.

REFERENCES:

1. http://www.vis-sim.org/

2. http://www.vis-sim.org/db.asp?cat_ref=2

3. http://www.vis-sim.org/db.asp?cat_ref=3

KEYWORDS: Test; Measurement; Visual; Display; Training; Simulator

N03-181 TITLE: <u>Global Information Grid (GIG)-Enabling Middleware (MW) Portals</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT II

OBJECTIVE: Develop an advanced prototype information exchange and data transfer portal between commercial web-enabled MW technologies and military MW technologies that can enable rapid integration of advanced airborne battle management system (ABMS) applications onto the E-2C mission computer and bridge the commercial and military technology life cycles.

DESCRIPTION: Technology infusion into the E-2C has been impaired by the cost and length of time attending software development, integration, and testing of inherently incompatible software application designs. That is, the applications are not designed to accommodate modular upgrades to software, hardware, and operating systems over the life cycle of the E-2C airframe. Data intensive commercial applications such as banking, telecommunications operations and system support (OSS) and government agencies such as the Federal Bureau of Investigation have turned to various MW products to isolate their applications from a specific hardware/operating system combination. Fierce commercial competition and an insatiable demand for more rapid and robust computer processing have reduced the computing technology life cycles in some domains to less than three years. Conversely, E-2C requirements for interoperability across evolving GIG architectural configurations could span five to ten years or more, affecting multiple aircraft configurations. As such, it is anticipated that the E-2C will be required to bridge gaps created by rapid commercial web-enabled MW migration to ensure continued interoperability across evolving GIG architectures. The Navy is seeking an advanced prototype software portal that interfaces commercial and militarized MW products for an E-2C application. Once established, the portal will be used to provide quantitative data on the potential for rapidly increasing operational capability and Fleet deliveries through the integration of commercial and military MW technologies into an E-2C GIG-enabled architecture.

PHASE I: Design a MW portal that enables cost-effective interoperability between commercial MW implementation and other DoD combat system MW products. Analyze the anticipated levels of interoperability based on a set of government standards [e.g., Defense Infrastructure Information/Common Operating Environment (DIICOE), GIG Capstone Requirements Document (CRD), etc.]

PHASE II: Develop and demonstrate the ability to interface the real-time execution decision support (REDS)/ABMS application to another combat system application through multiple MW products. Document the software development process and provide an initial analysis of the potential impact on performance, power, weight, space and cost.

PHASE III: Develop transition plans and demonstrate the airborne use of this portal design on a deployable unit that meets or exceeds the performance specifications of the existing legacy application. Conduct feasibility testing to evaluate performance in the Navy environment and develop acquisition and life-cycle-cost estimates.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial interest in the ability to upgrade legacy applications is at an all time high. The future market for this capability centers on thousands of federal, state, municipal, and local governmental activities with exigent requirements to interface with each other to provide a dynamic rapidly integrated, affordable portals leading to synergy of effort supporting a dynamic range of information exchange/transfer quality of service (QoS) across and within dissimilar sensor, communications, and computing architectures, in support of a broad range of Homeland Defense missions.

REFERENCES:

1. Bowden, Larry, and McIntyre, Brett. "The Powerful Combination of Enterprise Portal and Content Management Infrastructure – Creating A Dynamic Portal Experience." Special Supplement to KMWorld, IBM Corporation, March 2002.

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5. "AS-5789 SEGMENT SPECIFICATION FOR E-2C MISSION COMPUTER UPGRADE", Version 9.1, Naval Air Systems Command.

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7. Multi-purpose Transportable Middleware (MTM), Digital System Resources, Inc. Open source available at <http://www.dsrnet.com>.

KEYWORDS: Rapid COTS Insertion; Portable Software; Middleware; Cost Reduction; Affordable; Upgrade

N03-182 TITLE: Integrated Communication Link and Global Positioning System (GPS) for Enhanced, Robust Position Information

TECHNOLOGY AREAS: Air Platform, Information Systems

ACQUISITION PROGRAM: Dr. James Alper

OBJECTIVE: Design and prototype a system that will use existing or planned naval communication systems to enhance standard GPS operation by connecting users in line-of-sight environments where GPS signals are partially blocked or jammed.

DESCRIPTION: Air platform and weapon navigation systems encounter situations where GPS signal reception is deteriorated, making the position and time information less reliable or unavailable. This new capability is to be compatible with selective availability and anti-spoofing modules (SAASM) and future naval aviation core avionics systems. The augmented GPS system with a communications link is necessary for navigation and time critical targeting to increase mission effectiveness in areas of partial GPS coverage or jamming.

PHASE I: Develop concepts to verify innovative approaches for utilizing existing or planned communication data links among multiple users to augment standard GPS. Examine navigation oriented algorithms for mitigating the current problematic effects of an accurate, common time reference and multi-path in time difference of arrival (TDOA) systems. Examine existing communication data links, algorithms, and algorithm development to combine existing and new identified technologies with GPS position information, develop a ranging error model and characterize accuracy among multiple air and surface users.

PHASE II: Develop a distributed GPS geolocation solution using existing communication links; refine factors that effect performance, identify limitations and develop algorithms to combine selected technology in Phase I and partial GPS information to provide a complete network geo-location. Demonstrate in the lab the ability to successfully integrate the tested algorithms into existing and modified communication/GPS systems.

PHASE III: Tailor solution(s) identified in phase I and demonstrated in phase II to interested air platform navigational and weapon systems. Build and fly in a representative military aircraft in a GPS jamming environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Homeland Defense Commercial Air Traffic Control resistance to terrorist jamming.

REFERENCES:

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2. Kaplan, Elliott D. Understanding GPS: Principles and Applications. Artech House, 1996.

3. Kaplan, Elliott D. Naval Aviation Core Avionics Master Plan, 13200 Ser 780G/1U661359, 4 May 2001.

KEYWORDS: Integrated GPS; Signal Jamming; Geolocation; Situational Awareness; TDOA; Line of Sight

N03-183 TITLE: Miniature Low-Cost Bandwidth Efficient Advanced Modulation (BEAM) Transceiver for Small Uninhabited Aerial Vehicles (UAVs)

TECHNOLOGY AREAS: Air Platform, Information Systems, Sensors

ACQUISITION PROGRAM: AIR 1.0: ACAT IV

OBJECTIVE: Develop a miniature low-cost BEAM transceiver for transmitting, receiving, and relaying digital data and imagery to and from UAVs to the BEAM compatible NAVAIR electronic protection radio AN/ARC-210 RT-1851.

DESCRIPTION: Develop a miniature low-cost transceiver that uses the BEAM (see reference (1)) waveform to transmit, receive, and relay digital data and images from small uninhabited aerial platforms in the 225- to 400-MHz band. The transceiver should implement innovative techniques to support simultaneous transmission and reception of data using a single UAV antenna and provide a potential physical/data link, network layer for backup air vehicle control. The BEAM waveform increases the standard UHF 25-KHz channel up to 100 Kbps. The miniature transceiver should be state-of-the-art, and support up to 100-Kbps transmission rates in a 25-KHz line of sight (LOS) channel. The transceiver should be capable of transmitting a minimum of 10 watts output power continuously, while operating on a UAV air platform. The transceiver should use 28V power and weigh less than 5 lbs.

PHASE I: Develop and evaluate a design approach for a miniature transceiver and optimize the design for minimum size, weight, and cost. The transceiver will use the BEAM waveform modulation and UAV for power.

PHASE II: Develop a functional laboratory model to demonstrate transmit and relay digital data and images to and from an AN/ARC-210 RT-1851 using BEAM, a single antenna, and networking application software. The design must also have a path to Joint Tactical Radio System (JTRS) software communication architecture (SCA) compliance.

PHASE III: Repackage laboratory model into a flight worthy design and demonstrate transmit and relay capability to and from an aircraft equipped with an AN/ARC-210 RT-1851.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High data rate transmissions would more efficiently use available spectrum for commercial radio frequency (RF) applications.

REFERENCES:

1. Proposed MIL-STD-188-181C, Interface Standard, Interoperability Standard for Single-Access 5-kHz and 25-kHz UHF Satellite Communication Channels dated 30 September 2001.

2. Joint Tactical Radio System (JTRS) Software Communication Architecture Document Set, JTRS SCA Version 2.2, can be downloaded from http://www.jtrs.saalt.army.mil/

KEYWORDS: BEAM; Radio; Transceiver; Digital Images; Waveform; ARC-210

N03-184 TITLE: Active Balancing for Lift Fan Drive Shaft

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Stirke Fighter

OBJECTIVE: Develop an active balancing system to reduce or eliminate drive shaft vibrations caused by rotational dynamics to prevent maintenance of the lift fan drive shaft, which requires removal of the engine.

DESCRIPTION: The F-35 short takeoff/vertical landing (STOVL) configuration uses couplings at each end of the lift fan drive shaft. These allow for misalignment in the system but cause imbalance. In addition, the drive shaft when fatigued throughout the aircraft life may become deformed. Having the capability to actively adjust the rotational dynamics of the drive shaft without performing time-consuming maintenance could reduce the cost of ownership.

The current lift system design requires the drive shaft to rotate at an extremely high rate between 5000-8500 rotations per minute. This results in maximum vibrations of approximately 5 inch/sec at the clutch coupling and 4 inch/sec at the engine fan coupling. The shaft is also required to transfer nearly 28000 shaft-HP to the clutch and lift fan. There has been limited research into such a system, although the benefits to the F-35 STOVL configuration would be substantial. The development of a system, which would eliminate this vibration in the shaft, would be beneficial to the overall vibrational mode of the aircraft during lift fan operation.

PHASE I: Demonstrate feasibility by performing rotational dynamics testing. Analyze the results and develop a concept for actively balancing the drive shaft.

PHASE II: Develop a prototype active balancing system. Analytically ensure it is capable of reducing imbalance in the drive shaft at all possible rotational speeds and deflections of the drive shaft.

PHASE III: Perform sensor testing of the balancing system to ensure it will perform up to specifications. Perform final performance capability testing on an actual drive shaft in an F-35 STOVL variant.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This balancing technique could easily be applied to any rotating drive shaft where rotational dynamics are an issue resulting in significant savings in terms of maintenance and replacement. Aircraft using variable pitch propellers could also benefit from such a system.

REFERENCES:

1. Bevilaqua, Dr. Paul. "Development of Shaft Driven Lift Fan Concept." International Powered Lift Conference Proceedings, pp. 319-340.

2. Dyer, Steven W., Adaptive Optimal Control of Active Balancing Systems for High-Speed Rotating Machinery, 1999.

KEYWORDS: Rotational Dynamics; Active Balancing; Drive Shaft; Lift Fan; Vibrations; Propulsion

N03-185 TITLE: High-Temperature Lubricant

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop lubricants capable of enduring the extreme temperatures of the Joint Strike Fighter (JSF) lift system three-bearing swivel duct.

DESCRIPTION: The lift system three-bearing swivel duct (3BSD) operates at high temperatures and incorporates large moving parts. These parts will require a lubricant that can endure extreme temperatures (+625 F°) and remain chemically stable (no performance degradation) for the life of the three-bearing swivel duct (4,000 hours). The lubricant must also allow easy movement of the three bearing swivel duct throughout its full temperature operating range (-40° F to 625 °F). Current lubricants used in the 3BSD mechanical components can maintain viscosity but not throughout the entire range of operation. Current lubricants being considered for the 3BSD mechanical components maintain their chemical properties from -40°F to 280°F.

The life cycle of the 3BSD depends upon the reliability of the lubricant used in the mechanical components. This lubricant will greatly affect how well the 3BSD will be able to perform during operation. The lubricant itself will not degrade as a result of age. It simply needs to maintain its viscosity within the -40º F to 625º F range. An advanced lubricant capable of maintaining its chemical properties throughout the wide range of temperatures, which the 3BSD is required to operate, would lengthen the life of the 3BSD and its mechanical components significantly.

PHASE I: Demonstrate the feasibility of developing a high-temperature lubricant for the three-bearing swivel duct. Perform compatibility tests with three-bearing swivel duct-bearing materials. Perform pot testing at high temperatures to provide results showing the capability of the lubricant.

PHASE II: Assess lubrication performance at extreme temperatures for duration of three bearing swivel duct full life. Utilize loading data provided by the OEM to begin testing. Perform testing on small-scale bearings at three bearing swivel duct operating and maintenance temperatures and loads to provide results showing the capability of the lubricant.

PHASE III: Perform tests on an actual three-bearing swivel duct to demonstrate full life operation at three bearing swivel duct loads and temperature. Determine other beneficial applications of this product.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Applications could be translated to commercial high-temperature mechanical systems. Any results (understanding) gained from applying these technologies to the JSF lift-fan and three-bearing swivel duct would provide significant crossover benefit to other similar applications.

REFERENCES:

1. Blanski, Dr. Rusty. High-Temperature Gas Turbine Engine Lubricants. March 2002

2. Denis, Jacques. Lubricant properties analysis & testing. Paris. Editions Technip, 2000.

KEYWORDS: High Temperature; Lubricant; Swivel Duct; Bearing; Lift System; Mechanical Systems

N03-186 TITLE: Lift Fan Clutch Plate Material

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop an innovative clutch plate material and clutch plate configuration capable of enduring the service life of the lift fan in the F-35.

DESCRIPTION: Current carbon-carbon clutch plate materials meet the 1,500 engagement requirements, but this is well below the life requirements for the other lift fan components. The lift fan is expected to have a life of 4,000 aircraft flight hours. A new clutch plate material is required to increase service life. The lift fan clutch is a dry clutch. Advanced materials are needed to decrease wear rates while providing a dynamic coefficient of friction of 0.2 – 0.25 and a static coefficient of friction not to exceed 0.2 – 0.25.

The lift system design requires the clutch to deliver approximately 4000-6000 horsepower between the drive shaft and the lift fan. This material will need to engage at approximately 6800 rotations per minute with no chatter and minimal wear. Advanced alternative clutch components would also be beneficial for increasing usage life, reducing maintenance actions, and decreasing cost of ownership.

PHASE I: Demonstrate technical merit of proposed clutch technology and materials to meet operational parameters. Consider advanced materials capable of meeting JSF clutch requirements.

PHASE II: Develop prototype materials and demonstrate materials ability to meet performance requirements. Produce research showing the capabilities of this material in the STOVL clutch environment. Assemble a test schedule for endurance testing a prototype clutch.

PHASE III: Perform full-scale endurance testing of prototype clutch and transition technology into a production model for field testing on an F-35.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Technology developed for this clutch would be advantageous to any company using dry clutch designs and could benefit by extended service life. Brake systems could also benefit from this technology.

REFERENCES:

1. Hazen, Judith Ray. High Performance Composite Source Book. Vol. II, No. 6.

2. Bevilaqua, Dr. Paul. "Development of Shaft Driven Lift Fan Concept," International Powered Lift Conference Proceedings, pp. 319-340.

KEYWORDS: Clutch Plate; Lift Fan; Dry Clutch; Carbon-Carbon; Materials; Service Life

N03-187 TITLE: High Fuel-to-Air Ratio (FAR) Development Tool

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop modeling tools that accurately predict aero-thermodynamic conditions of gas turbine engines in high FAR combustors.

DESCRIPTION: Military aircraft engines currently in development for the Joint Strike Force (JSF) program operate at FARs well above those currently in production. The physical and chemical characteristics of combustion at these temperature and FAR conditions are not well understood. Current equilibrium assumptions may not be valid when a significant portion of the combusting flow is at or above stoichiometric conditions. Improved modeling and predictive capabilities that take these issues into consideration are needed. Use of such models will improve the combustor design cycle by predicting combustor exit conditions more accurately and by allowing combustor design changes to be evaluated prior to test, leading to more efficient rig test programs.

PHASE I: Develop a combustor model applicable to a military gas turbine engine. Demonstrate the capability of the model to predict accurately theoretical combustor internal and exit conditions (e.g., efficiency, temperature profile, species concentration) for operation below stoichiometric levels. Extend the prediction to conditions where a substantial portion of the combustor volume is above stoichiometric conditions. Demonstrate the nonlinear change in combustor performance due to high FAR effects. Identify the pertinent parameters that have the most effect on performance.

PHASE II: Refine the model as necessary. Evaluate the accuracy of the model by comparing predictions to experimental data. Experimental data are to be obtained via sub-scale or sector testing, which maintains relevance to military gas turbine engine cycles. Prototype hardware must therefore be fabricated and tested or access to experimental data otherwise obtained. Demonstrate the capability of the model to predict experimental results at moderate and high overall FARs accurately.

PHASE III: Refine the model as necessary. Apply the model to a specific JSF engine or component. Demonstrate the model's capability to predict JSF combustor performance accurately, and verify by comparison to combustor rig and full engine test data.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This modeling capability would be applicable to any industry requiring high FAR combustion. Commercial aircraft engine and industrial gas turbines generally avoid near stoichiometric combustion for durability reasons but these markets may benefit nonetheless from the improvements in combustion modeling accuracy, leading to significant cost savings by allowing for analytical solutions early in the design process.

REFERENCES:

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2. Smiljanovski, Vanco, and Brehm, Norbert. "CFD Liquid Spray Combustion Analysis of a Single Annular Gas Turbine Combustor," AMSE Paper 99-GT-300, June 1999.

3. Mongia, H.C., et al. "Combustion Research Needs for Helping Development of Next Generation Advanced Combustors," AIAA Paper 2001-3853, July 2001.

4. Malecki, Robert E., et al. "Application of an Advanced CFD-Based Analysis System to the PW6000 Combustor to Optimize Exit Temperature Distribution - Part I: Description and Validation of the Analysis Tool," ASME Paper 2001-GT-0062, July 2001.

5. Buclow, P.E.O., et al. "Application of Two-Phase CFD Analysis to a Prefilming Pure-Airblast Atomizer," AIAA Paper 2001-3938, July 2001.

KEYWORDS: Modeling; Combustion; Fuel-Air Ratio (FAR); Stoichiometry; Equilibrium; Efficiency

N03-188 TITLE: High Source Level Plasma Sparkers Driven by High-Energy Density Capacitors for Navy Applications

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-A: ACAT II

OBJECTIVE: Develop and fabricate efficient, high-intensity low-cost sparker technology using new high-energy density capacitor technology, for use in ocean environmental measurements, electromagnetics, acoustic/electromagnetic countermeasures, force protection visual trip wires, and anti-biofouling.

DESCRIPTION: Under previous SBIR contracts, the Navy and Army Corps of Engineers focused on technology that is essential for the development of cost-effective, high-efficiency sparker technology for use in ocean environmental measurements, electromagnetic countermeasures, and anti-biofouling. The sparker is an electrically driven impulsive technology that in water emits a series of strong pressure pulses, similar to explosives, and in air creates a broad electromagnetic interference as well as a blinding light. The focus of the Navy and Army Corps of Engineers has been on increased source level in a fixed package. A successful demonstration of the technology in salt water has produced acoustic source levels of 197 dB (ref. uPa ^2 @ 1 m, ref. 1 sec) [see ref. 1] in an A-size (4.875-inch-diameter by 36-inch-long) sonobuoy form factor. Future sparker systems must conform to a form factor of one-third A size (4.875 inches by 12 inches long). In current sparkers, the capacitors occupy the largest volume. New developments in high-energy density (i.e., stored electrical energy per unit volume) capacitor technology that can meet sparker operating requirements have the potential to increase the source level. Nevertheless, since the final developed sparker module will be mass-produced in an expendable sonobuoy system, emphasis on cost is paramount. New high-energy density capacitor technologies must be low-cost for Navy applications.

PHASE I: Evaluate alternative high-energy density capacitor technologies for use in sparker modules. For promising capacitor technology candidates, evaluate their feasibility to meet sparker electrical requirements. Estimate the increase in energy density and cost implications of capacitor technologies that pass the electrical tests.

PHASE II: Develop detailed designs, using the new capacitor technology or technologies for a low-cost sparker. Fabricate sparker modules and demonstrate performance in tests at sea. Design and test a prototype at sea.

PHASE III: Develop a production design and integrate it into Navy/Army systems upon meeting requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential commercial use is for biofouling control of Zebra mussels and other aquatic nuisance species. The Zebra mussel (Dreissena polymorpha) is a small freshwater mussel that was accidentally introduced into the Great Lakes from Europe in the late 1980s. Zebra mussels tolerate extreme crowding, and can clog intake pipes, filters, trash racks, and other components of ships, dams, pumping plants, and hydropower facilities that use freshwater. These mussels can be controlled by use of a plasma sparker (Mackie, et. al., 1999, Welch, et. al., 2000). The plasma sparker is an environmentally benign method and can be used when chemicals, hot water, or filters cannot be used to control these pests.

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2. Flynn, D.F. "Tactical Acoustic Measurement and Decision Aid Environmental Sonobuoy Program." NAVAIR, 2000.

KEYWORDS: Sonobuoys; Sensors; Localization; Environment; Acoustic Sources; Countermeasures

N03-189 TITLE: Sonobuoy Networking Technology

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-A: ACAT III

OBJECTIVE: Develop true multi-node, routed networking among air-launched drifting sonobuoys and tactical users at line of sight (LOS) ranges (2 to 6 miles) and beyond LOS (up to 120 miles) with relay.

DESCRIPTION: Current free-drifting sonobuoy systems provide information that is uplinked (point-to-point) on a very high frequency (VHF) to distribute collected data needed by the aircrew to detect, localize, track, and attack hostile submarines. The addition of a capability for multiple-sensor node and platform networking is essential in the future utilization of sonobuoys in a network-centric battlespace. True multi-node, routed networking among sonobuoys, with improved telemetry permitting higher bandwidth data to be transmitted from platform to platform and from deployed sensors to platform and shore stations, unmanned autonomous vehicles, surface vessels, submarines, aircraft, and shore-based installations is highly desirable. A local area network (with or without a gateway to a wider area Internet) is envisioned using standard or modified commercial off-the-shelf (COTS) protocols with the capability of point-to-point, peer-to-peer, and multicast connectivity among multiple sensor nodes and platforms. An important point is that any intra-platform communication protocol should not be selected with simple point-to-point applications in mind so that obstacles for future multiple-node networking can be avoided. Further, sensor networks should be self-organizing to permit an easy deployment and to be fault tolerant. Traffic should be evenly distributed over all the nodes, such that all nodes die approximately at the same time within given power constraints.

PHASE I: Conceptually develop a sensor system capable of meeting the size and power limitations posed by a small-diameter sonobuoy housing, operating at low power levels. Conceptually develop an addressable multi-node sensor suite via multi-cast, peer-to-peer, and point-to-point connectivity, including routing and relay functions.

PHASE II: Develop the hardware and software requirements and assemble a prototype multi-node sensor suite, including routing and relay functions, for a laboratory demonstration. Conduct representative field tests applicable to the final environment.

PHASE III: Develop a production design of the Phase II solution. Conduct integrated testing of representative "over-the-side" sensors, including routing and relay functions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This concept may have multiple applications to other unattended sensors used in scientific oceanography, terrestrial military operations, and homeland defense.

REFERENCES:

1. Flynn, D.F. "Tactical Acoustic Measurement and Decision Aid Environmental Sonobuoy Program." NAVAIR, 2000.

KEYWORDS: Sonobuoys; Sensors; Localization; Environment; Network; Antisubmarine Warfare (ASW) Tactics

N03-190 TITLE: Helicopter Operations Aircrew/Crew Chief Trainer

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop innovative simulator technology for the enhancement of crew chief personnel training in crew chief and pilot interactions.

DESCRIPTION: Recent developments in the modeling and simulation industry have made it possible to create affordable simulators to train positions like that of the helicopter crew chief in a Navy, Marine Corps, Army, or Coast Guard helicopter environment. It is proposed that a computer-generated visual environment, with computer-generated flight crew audio communications, be coupled with portable motion-based platforms into a crew chief operations trainer. The crew chief simulator could provide training for all crewmen in operations such as door gunner target engagement and tactical environments, interactions with pilots during search and rescue (SAR) operations including swimmer deployment and recovery, hoist operations and malfunctions, night search aided and unaided, SAR, mine and Doppler operations, as well as aircraft emergencies such as fires and hydraulic leaks.

PHASE I: Demonstrate the feasibility and affordability of the proposed simulator to optimally complement training requirements for aircrew operations.

PHASE II: Develop a prototype and evaluate simulator effectiveness to provide required training to crew chief personnel. Trainers should be compact in size and designed for rugged use because they will be located with the Fleet replacement squadron (FRS).

PHASE III: Transition crew chief trainer(s) to Navy, Marine Corps, Army, and Coast Guard training facilities throughout the world.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to Coast Guard, Forestry, emergency medical services (EMS) and law enforcement organizations responsible for the training of helicopter cabin crew personnel.

REFERENCES:
1. NATOPS SH-60: NAVAIR A1-H60BB-NFM-000, Training System Functional Description for MH-60S Multi-Mission Helicopter 497-FY02-015.

KEYWORDS: Helicopter Crew Chief; Search and Rescue; Hoist Operations; Door Gunner; Special Operations; Trainer

N03-191 TITLE: Imagery Automatic Extraction/Precision Placement of Wavelength-Independent Texture (WIT)

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Generate rapid and accurate real-world WIT maps from national imagery in visual and sensor databases for mission rehearsal and training.

DESCRIPTION: Current automatic methods of generating WIT maps are inherently inaccurate; manual methods, which generate surface material codes (SMCs), achieve simplistic results and are time and labor intensive. Traditional spectral behavior of visual and sensor database scene elements has been via application of SMCs to designated scene elements. These are deterministic representations of a portion of the electromagnetic response (e.g., near infrared) of an object or aggregate of objects to approximate spectral response in a narrow band. Out-of-band response (e.g., radar) is not available or not predictable. WIT maps rely on probabilistic methods to allow characterization of the complete spectral response of database scene elements.

PHASE I: Determine the feasibility of inserting off-the-shelf hardware into a system that extracts WIT maps from national imagery (e.g., digital point positioning data base (DPPDB), Controlled Image Base (CIB)). This system should ingest imagery and existing phototexture; generate accurate emissivity, transmissivity, absorptivity, reflectivity, and radiance functions and textures over the microwave, optical, near-, and far-infrared bands; produce compressed standard texture formats; and accurately index resulting texture to corresponding real-world visual database terrain and culture locations. Establish confidence metrics to guide database developers in the reliability of the resulting products.

PHASE II: Develop and test the WIT map extraction system utilizing national imagery and applying standard lossless compression (e.g., wavelet or JPEG2000) and file formats (e.g., .flt, SHAPE, .dxf, etc.) to a real-world terrain database. Demonstrate the accuracy and efficiency of the results utilizing sensors of various wavelengths (radar, visual, night vision goggles (NVG), and forward looking infrared radar (FLIR)). Include confidence metrics with the resulting product. Demonstrate storage efficiency and high-bandwidth texture performance.

PHASE III: Prepare user-friendly commercial off-the-shelf (COTS) tools for use by imagery analysts, cartographers, and database developers in civilian and military work environments.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Military training and intelligence organizations and commercial enterprises needing rapid, reliable, and accurate visual and sensor database productivity to support fast-response analysis and rehearsal requirements.

REFERENCES:
1. “Pathfinder 2001 Scene Visualization Data Production & Exchange (SVDP/E),” Final Report, National Imagery and Mapping Agency, December 2000.

KEYWORDS: Phototexture; Wavelength Independence; Feature Extraction; Visual Databases; Sensor Databases; Database Tools

N03-192 TITLE: <u>Enhanced Understandability and Effectiveness for Joint Strike Fighter (JSF) Automatic Logistic Products</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Establish approaches to enhance understandability and effectiveness of interactive electronic technical manuals (IETMs).

DESCRIPTION: The U.S. military has adopted IETMs for maintenance documentation. Maximal effectiveness of IETMs requires that the interaction be mediated through identification of semantic meanings by the computer system delivering the information as well as the user, so that only that information needed by the user is delivered. The European members of NATO have adopted a universal design concept in moving to make Simplified English Language (SEL) a requirement for military aircraft documentation. SEL can be effective in enhancing user understanding, and can be further enhanced with augmentation to address lexical differences between American English and British English. However, the efficiency and effectiveness of the material presented to the user can be more dramatically impacted with a semantic tool that more closely identifies and delivers the knowledge that the user requires and is seeking. The Enhanced Understandability and Effectiveness for Joint Strike Fighter (JSF) Autonomic Logistic Products will utilize existing tools for creating SEL compliant documentation to address the lexical differences in American and British English, as well as limit the syntax and lexicons that both users and IETM delivery system must contend. In addition, it will develop and utilize semantic tools to identify meaning in the interactions in order to maximize the efficiency and effectiveness of information exchange between the user and the IETMS so that the specific information required by the user is delivered in the most expeditious and efficient manner possible.

PHASE I: Determine the feasibility of attaching semantic meaning to existing SEL.

PHASE II: Develop and correlate American English and British English SEL lexicons. Then develop semantic tools and demonstrate extent that semantically guided interaction can increase the efficiency and effectiveness of IETMs.

PHASE III: Transition the enhanced technology to JSF courseware as well as other military and commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Globalization in all aspects of technology heightens the need for universally understandable documentation to support increasingly technically intense systems. Improving understanding with semantic tools would magnify the impact of the efforts using SEL being made by Boeing, Caterpillar, and the European Association of Aerospace Industries (AECMA).

REFERENCES:
1. Chervak, Drury, and Ouellette. "Field Evaluation of Simplified English for Aircraft Workcards," Chapter X, Report No. DOT/FAA/AM-96/xx, 1996.

2. Spyridakis, J. H., Holmback, H., and Shubert, S. K. "Measuring the Translatability of Simplified English in Procedural Documents," IEEE Trans. Prof. Comm., Vol. 40, 1997, pp. 4-12.

3. AECMA Simplified English Standard (1998). "A Guide for the Preparation of Aircraft Maintenance Documentation in the International Aerospace Maintenance Language," AECMA Document PSC-85-16598, Belgium: The European Association of Aerospace Industries.

4. Patel, Drury, and Lofgren. "Design of Workcards for Aircraft Inspection." Applied Ergonomics, 25(5), 1994, pp. 283-293.

KEYWORDS: Structured English; Simplified English; Controlled English; IETMs; Authoring

N03-193 TITLE: <u>Non-Chromated Flexible Aircraft Primer Containing Zero Volatile Organic Compounds (VOCs)</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop a primer for Naval aircraft applications containing no chromated corrosion inhibitors and VOCs, and exhibiting exceptional flexibility.

DESCRIPTION: The Navy and the Air Force currently use a flexible primer as the primary component of the corrosion-prevention finishing system on various aircraft. This step is necessary to prevent film cracking at low temperatures (-60„aF) and subsequent corrosion, primarily at high-flexing components and fastener patterns. The current flexible primer contains chromated corrosion inhibitors and organic solvents. The chromated compounds have been identified as oxidizers, toxic heavy metals, and carcinogens, and the elimination of their use has been mandated at all levels of government. The Environmental Protection Agency has proposed a reduction in low-level ozone non-attainment levels within the National Ambient Air Quality Standards. Because VOCs contribute to the generation of low-level ozone, State and local agencies may require VOC reductions beyond those listed in the aerospace National Emission Standards for Hazardous Air Pollutants, especially in southern California. This is particularly crucial because most Navy rework involving high-flexing aircraft components is performed at the Naval Air Depot, North Island in southern California.

PHASE I: Initial development efforts should incorporate non-chromated corrosion inhibitors into a polymeric binder system to produce a sprayable, flexible coating without organic solvents for use on Navy aircraft. The coating must meet the performance requirements of the current military specification as well as be compatible with existing pretreatments and topcoats. It must be able to be applied using current spray equipment and have similar curing properties.

PHASE II: Develop, test, and field demonstrate the coating.

PHASE III: The coating will be transitioned to the Fleet through specification modifications and revisions to the aircraft weapon system technical manuals. If further development and/or field-testing are required, aircraft program funding or demonstration program funds will be pursued.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Successful coating can be used on commercial aircraft as well as by other DoD aircraft.

REFERENCES:
1. TT-P-2760 ¡V Primer Coating: Polyurethane, Elastomeric, High-Solids

2. MIL-C-85285 ¡V Coating: Polyurethane, High-Solids

3. MIL-C-81706/5541 ¡V Chemical Conversion Materials For Coating Aluminum and Aluminum Alloys/Chemical Conversion Coatings on Aluminum Alloys

4. TT-P-2756 ¡V Polyurethane Coating: Self Priming Topcoat, Low Volatile Organic Compounds (VOC)

KEYWORDS: Primer; Coating; Non-Chromated; Chromates; Flexible; Zero VOC

N03-194 TITLE: <u>High-Bandwidth Photodetector for Missile Applications</u>

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO T: ACAT IC

OBJECTIVE: Develop a cost-effective, high-bandwidth, high-gain, large active area photodetector that is appropriate for use in a missile system environment.

DESCRIPTION: Active optical sensors have been used in missile systems for decades. Advances in high-sensitivity photodetectors in recent years have provided the opportunity for significant gains in performance from active optical sensors. A cost-effective, high-bandwidth, high-gain, large active area photodetector that can operate in a missile environment is required to take advantage of these performance gains. Environmental parameters include storage and operation over a very wide temperature range (-54o to +71o C for storage and -40 o to +74 o C for operation), rapid transition from Off state to On state, long storage times, and operation in a harsh vibration environment. This detector should be capable of providing a minimum of 1 GHz electronic bandwidth, gain of 800, and active area of 8 mm in diameter. The detector will need to be highly sensitive at a wavelength of 532 nm. The detector and associated electronics should take less than 6 cubic inches of volume.

PHASE I: Develop a conceptual design for a detector that meets the environmental and performance requirements for operation in a missile system. This should include the detector design as well as any associated electronics needed to bias the detector and any electronics necessary for an integrated trans-impedance amplifier.

PHASE II: Develop detailed designs for the Phase I detector and fabricate a limited number of detectors (including associated electronics) suitable for environmental testing. Conduct testing of these detectors under simulated environmental conditions.

PHASE III: The detector, upon meeting requirements, will be transitioned into a Navy missile system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be used in rugged laser rangefinders.

REFERENCES:
1. Scott, Al. "Intensified Photodiodes Sense Low Light Levels," Laser Focus World, November 1995, p. 115.

KEYWORDS: Photodetector; LADAR; High Bandwidth; High Gain; Large Active Area; Photocathode

N03-195 TITLE: Diagnostic and Health Monitoring Techniques for Engine Nozzle Actuation Hardware

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: The primary objective is to develop the necessary sensors and algorithms to diagnose failures and monitor the health of short takeoff/vertical landing (STOVL) engine exhaust nozzle hardware. A secondary objective is to project the useful remaining life of the nozzle and actuation hardware.

DESCRIPTION: The models should address intended and actual operational performance and deviation from expected performance, detect latent failures of nozzle actuation control components, and be usable in software open architectures such as open system architecture for condition based maintenance (OSA-CBM). Emerging applications of STOVL technology will need reliable diagnostic and prognostic sensors, connectors, and algorithms for articulating nozzles to help assure safe flight operations when deployed at sea. Diagnostic, prognostic, and health monitoring techniques developed for the JSF-135 nozzle will also be applicable to legacy applications as well.

PHASE I: Determine the feasibility for assessing the likelihood of successful nozzle conversion operation. Model the recommended algorithms and sensors. Demonstrate the diagnostic routine's ability to detect latent failures and the model's ability to trend useful life remaining.

PHASE II: Develop the necessary architecture, sensor suite, wiring harnesses, and algorithms required to estimate nozzle system components useful life remaining, detect latent failures in nozzle actuation control system, and estimate the likelihood of successful operation of the nozzle. Demonstrate a prototype system in an engine test cell environment.

PHASE III: Demonstrate the system on board an aircraft with flight-cleared hardware. Prototype the maintenance activities related to the applied state of health system. Incorporate the aircraft engine nozzle health monitoring system technologies on new production and legacy applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: An aircraft engine nozzle state of health system would have broad application to commercial aviation.

REFERENCES:
1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey, "Autonomic Logistics—The Support Concept for the 21st Century," IEEE Proceedings, Track 11, paper zf11_0701.

2. Byer, Bob, Hess, Andy, and Fila, Leo, "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics," Aerospace Conference 2001, IEEE Proceedings, vol. 6, pp. 3095, 3103

KEYWORDS: Condition Based Maintenance; Diagnostics; Prognostics; Engine Nozzle; Actuation; Algorithms

N03-196 TITLE: Techniques, Processes, and Tools for Managing the Relationship between Diagnostic and Prognostic Capabilities as Applied to Health Management Systems

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop the strategy, techniques, software, models, processes, and tools to manage the relationship between diagnostics and prognostics when trying to perform accurate model based predictive prognostics and diagnostic and prognostic capabilities are both available.

DESCRIPTION: Both diagnostic and prognostic capabilities, with their associated techniques, will be applied to modern health management systems like the JSF prognostic health management (PHM) system. Sometimes it is preferable to apply prognostic techniques to predict accurate useful life and/or performance life remaining. At other times, this becomes or is not possible; for example when a manufacturing or handling induced fault does not lend itself to modeling. Techniques and processes are needed to determine when to use diagnostic capabilities in situations where prognostics are being used but the failure progression driver becomes impossible.

PHASE I: Demonstrate feasibility of technology to "self -assess" prognostic and diagnostic capability and its ability to accurately determine when to use diagnostic capabilities when the prognostics are being used.

PHASE II: Develop the necessary system architecture, models, processes, and management tool sets. Develop system prototype to demonstrate system capabilities.

PHASE III: Incorporate these techniques, processes, software, models, and/or tools into the JSF PHM system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial aerospace industry where PHM is being used.

REFERENCES:
1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey, "Autonomic Logistics—The Support Concept for the 21st Century," IEEE Proceedings, Track 11, paper zf11_0701.

2. Byer, Bob, Hess, Andy, and Fila, Leo, "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics," Aerospace Conference 2001, IEEE Proceedings, vol. 6, pp. 3095, 3103.

KEYWORDS: Condition Based Maintenance; Diagnostics; Prognostics; Health Management; Modeling; Logistics

N03-197 TITLE: Techniques and Prognostic Models to Relate Useful Life Remaining and Performance Life Remaining Predictions to Detectable Fault Conditions in Electronic

System Power Supplies

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: ACAT I: Joint Strike Fighter

OBJECTIVE: Develop innovative statistical tools, models, and techniques that would define fault-to-failure progression models and provide accurate useful life remaining predictions for electronic system power supplies and their component elements.

DESCRIPTION: In order to fully enable the predictive part of any prognostic and health management (PHM) concept, there has to be some capability to relate detected incipient fault conditions to accurate useful life remaining predictions for any point in time. Key to accomplishing this is being able to understand incipient fault-to-failure progression characteristics for the component and/or subsystem of interest and having realistic and verifiable prognostic models. The systems and components of interest in this topic are electronic controls, radars, integrated core processors and/or any avionic systems found on board an aircraft. With these power supplies playing an important role in the operation of aircraft electronic systems and subsystems, it is important that the user be able to diagnose faults accurately and predict failures and life remaining of these components. This may be accomplished through the merging of an understanding of the particular physics of failure, analytical models, physical models, statistical techniques, and actual failure experience data. Some level of real-time sensor and/or measurable state awareness will be a required input to these prognostic models and techniques. This effort will develop, demonstrate, and apply these advanced prognostic and useful life remaining models in support of the predictive part of PHM on aircraft electronic system power supplies and their component elements.

PHASE I: Define the techniques and processes needed to relate useful life remaining predictions to detectable fault conditions in aircraft electronic system power supplies and their components. Demonstrate the technical merit of the proposed solution to detect incipient failure in an electronic system power supply component and accurately predict useful life remaining. Develop an initial list of required inputs to the models, and outline a method of extracting them from the aircraft. Models will be developed such that they can be run on a standard PC platform and optimized such that they utilize a minimum of computing resources. Define user interface.

PHASE II: Develop and demonstrate a prototype of these advanced models, techniques, and programs for several JSF application electronic system power supplies and their components. Assess the application boundaries, accuracy, and limitations for these modeling techniques.

PHASE III: Finalize these models with a major aircraft and/or engine manufacturer. Apply these modeling programs on the JSF program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These advanced models would be applicable to any electrical system application across industry and the private sector that will be applying diagnostic, prognostic, and health management capabilities. Any results (understanding) gained from applying these failure progression rate models to particular electrical systems will provide a significant crossover benefit to other similar applications, commercial or military.

REFERENCES:

1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. “Autonomic Logistics—The Support Concept for the 21st Century,” IEEE Proceedings, Track 11, paper zf11_0701.

2. Byer, Bob, Hess, Andy, and Fila, Leo. “Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics,” Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095, 3103.

KEYWORDS: Diagnostics; Prognostics; Modeling; Useful Life Remaining Predictions; Prognostics and Health Management; Failure Prediction

N03-198 TITLE: Dual-Band Electro-Optic (EO)/Infrared (IR) Multifunctional Pod Windows

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO-T: ACAT IC

OBJECTIVE: Develop a practical, cost-effective approach for the production of large, multi-spectral windows for use in airborne reconnaissance pods using aluminum oxide (Al2O3), also known as sapphire.

DESCRIPTION: As surveillance and tactical missions become more complex, with greater standoff ranges and overflight profiles required, there is a need to increase the performance of EO and IR systems to provide higher quality and higher resolution imagery. Typically, these EO and IR systems are combined into pods on tactical jet aircraft. The increasing sensor performance requires commensurate improvements in window design, so that the window does not limit the imaging capability of the sensors. These window performance improvements could include areas such as increased optical transmission, aperture, and optical quality. Similarly, the increasing proliferation of these EO/IR systems in tactical jet environments requires more robust window survivability and lower production cost. These window survivability improvements could include areas such as increased scratch resistance and window strength, so that the window can withstand a broad range of environmental and operating conditions experienced by supersonic military aircraft. In addition, these improved windows will provide an extended service life without degradation of performance.

Research into new processes, coatings, and polishing techniques, and material research into improving the overall price/performance of this type of window are required. Specifically, research into Al2O3 material and methods of shaping and polishing the windows to high optical specifications are required. Typical specifications would be dimensions on the order of 22" diagonal with 92 percent or greater throughput transmission from 0.4 microns to 5 microns, although larger wavebands and a thickness of .625 inch or less are desired. The polish requirement typically requires that the substrates be optically flat to 0.03 wave root mean square (RMS) roughness while simultaneously maintaining less than 5 seconds of wedge. The substrate must transmit over the large waveband in addition to being available with inherent low-cost manufacture processes.

PHASE I: Develop and demonstrate the feasibility of fabricating a large, optical quality sapphire window. Demonstrate methods of reducing the cost and extending service life while still maintaining performance of the multi-spectral window.

PHASE II: Develop a detailed process for the manufacture and qualification testing of a large, optical grade one-piece sapphire window. Deliver sample pieces along with necessary documentation to demonstrate the process. Provide at least two flight-capable test assets meeting the Shared Reconnaissance Pod (SHARP) system window design specification for test and evaluation.

PHASE III: Produce SHARP pod windows for procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Single crystal sapphire has a unique combination of physical, chemical, and optical properties allowing it to withstand high temperatures, high pressure, thermal shock, and water or sand erosion. It is chemically inert, with a low friction coefficient, and excellent electrical, optical, and dielectric characteristics. In addition, its radiation resistance makes it an excellent material for use in optical windows for aviation and space applications. Additionally, low cost windows of this nature will find commercial applications in communications, machine vision, and security surveillance.

REFERENCES:
1. Robert-Jaap van der Bijl, M., et al. "In-Process Monitoring of Grinding and Polishing of Optical Surfaces." Applied Optics, Vol. 39, No. 19, 1 July 2000.

2. Malyarenko, A. D., and Opt, J. "Automated Selection of Treatment Regimes for Polishing Optical

Surfaces." Technol, 67 (1), January 2000.

3. Walsh, Christopher J., et al. "Fabrication and Measurement of Optics for the Laser Interferometer Gravitational Wave Observatory." Applied Optics, Vol. 38, No. 13, 1 May 1999.

4. Blair, D.G., et al. "Development of Low-Loss Sapphire Mirrors." Applied Optics, Vol. 36, No. 1, 1 January 1997.

5. Leistner, et al. "Polishing Study Using Teflon and Pitch Laps to Produce Flat and Supersmooth Surfaces." Applied Optics, Optical Tech., Vol. 31, No. 10, April 1992.

KEYWORDS: Optical; Polishing; Generating; Sapphire; Cleartran; Multi-Spectral

N03-199 TITLE: <u>Low-Cost High-Power Laser Designator/Rangefinder for Intelligence, Surveillance, and Reconnaissance (ISR) Platforms</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-A; ACAT IC

OBJECTIVE: Develop a small form factor, low-power long-range laser rangefinder and designator for military ISR platforms.

DESCRIPTION: Current military ISR platforms with electro-optic (EO) imaging systems frequently support strike warfare missions. These platforms generally have very long range imaging performance, and can accurately locate small mobile targets such as transporter erector launchers (TELS) and tanks. However, the ability of these systems to pass the actual location of these targets to strike platforms is limited due to geo-location accuracy of the imaging system. Additionally, moving targets are difficult to geo-locate within a small enough window to support precision weapon placement, especially given target maneuvers. To support increased effectiveness of the ISR mission, the capability to designate targets directly for a strike package is desired, as well as providing on-board capability for laser guided munitions. However, integrating a laser designator into the current EO imaging systems on board these platforms (e.g., P-3C AIP, MH-60R, S-3), is cost prohibitive. The goal of this SBIR is to design a low-cost, high-power laser designator that has the following characteristics: 30 microradians or less of beam divergence; 5-microradian relative pointing stability based on cues from an external system; designed to meet military aircraft temperature and environment; and modulated to support laser rangefinding either continuous waveform (CW) or pulsed with an accuracy of 1 meter or less. This system must be easily mounted on an aircraft, must automatically boresight, and must maintain the boresight of the laser designation system to the on-board EO imaging system.

PHASE I: Design the proposed system and analyze range and stabilization performance. Model cooling and power requirements and provide cost. Assume that the on-board imaging system will provide inertial navigation system (INS) and steering data.

PHASE II: Develop, test and demonstrate prototype system.

PHASE III: This SBIR has applicability to multiple DoD services that require a method of designating targets at long range.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The private sector application for this product includes the commercial geo-spatial mapping agencies, as well as support for the laser industry.

REFERENCES:
1. Bowie, Christopher J., "Destroying Mobile Ground Targets in an Anti-Access Environment," www.capitolsource.net/files/mobile-ground-targets.pdf

2. MacRae, Catherine, “The Promise and Problem of Laser Weapons,” Air Force Magazine, December 2001, pp. 70-73

KEYWORDS: Laser Designator, Electro-Optic, Weapons, Targeting, Imaging, Time Critical Strike

N03-200 TITLE: Automated On-Board and Off-Board Data Timing and Synchronization

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop a low-cost method of synchronizing time for sensor and mission data for on-board and off-board systems using heterogeneous networks.

DESCRIPTION: A distributed system consists of autonomous computing and processing nodes linked together as a network, and supported by software and hardware that allow the system to operate as an integrated entity. As the Navy moves toward an integrated battlespace environment, the ability to determine accurately the timing of the data as it moves between elements of the distributed system is critical. There are a number of issues that arise when considering timing of data elements as they move from measurement through the network to the processing elements to the human machine interface (HMI). These elements include but are not limited to:

Latency: Latency or delay due to transmission of the data between points in a network can cause a significant impact to accurate processing and interpretation of data. For example, very short latency between the measurement of an aircraft navigation sensor and its input and processing by a mapping program can cause large errors in aircraft position displays to the operator.

Synchronization: External clock synchronization relates to the problem of using a universal time coordinated (UTC) reference for all clocks in a system. However, for widely distributed systems, inaccuracy in the measurement of the UTC reference and the limited accuracy of that reference (typically several milliseconds), limit the ability to clock the data elements with sufficient resolution.

Network Topology: For network centric warfare (NCW) systems, there are typically multiple network topologies in use. These topologies include multiple bus structures, real-time and non-real-time elements, and widely varying latencies for data in the system. For example, an aircraft will typically have a network topology that includes both deterministic (1553 bus, 1760 bus), and nondeterministic (Ethernet) busses. Timing data between these bus structures is difficult due to the widely varying latencies that occur on the nondeterministic bus, and the requirement to process data from both at the same time. Wireless networks also add challenges to timing due to degraded performance and rapidly changing latency.

Accuracy: Clock accuracy has improved due to the advent of global positioning system (GPS) technology. However, there are limitations to GPS timing that occur due to omissions and errors with the GPS receivers. Additionally, accuracy below 10 ns is desired, which requires that GPS technology (good down to ~100 ns) be complemented by additional techniques.

This SBIR should address the development of a clock synchronization methodology that includes a local clock scheme that is highly accurate (<10 ns), a mechanism to maintain a bound on external time reference errors, an interface to an external time source, time stamping capabilities for nondeterministic networks, latency characterization for nondeterministic networks, a standardized interface that is located next to the physical layer of a network, and a standardized interface.

PHASE I: Develop and demonstrate the feasibility to clock data to an accuracy <10 ns on a small network system. Address the capability of the proposed solution to address the issues listed above. Demonstrate the high accuracy clock, time stamping approach, and latency corrections for the distributed network with a deterministic bus.

PHASE II: Develop a breadboard hardware and software clocking solution and demonstrate it on a representative Navy airborne system using both deterministic and nondeterministic busses. Develop and document the application program interface (API) for the clocking solution.

PHASE III: This system is of high interest to the Navy's Network Centric Warfare technology area, and could be transitioned to multiple DoD platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: As wireless networks become more prevalent, accurate standalone timing solutions for messaging networks will become more critical. This is a high potential business area for the private sector.

REFERENCES:
1. Horauer, Holler. "Integration of High Accurate Clock Synchronization Into Ethernet-Based Distributed Systems", IEEE Transactions.

2. Lesser, et al. "BIG: An Agent for Resource-Bounded Information Gathering and Decision Making." Artificial Intelligence, Elsevier Science Publishing, 118(1-2), May 2000, pp. 197-244.

KEYWORDS: Clock Synchronization; Latency; Distributed Systems; Network Centric Warfare; Global Positioning System; Data Fusion

N03-201 TITLE: <u>An Integrated Antenna Set for Software Radios</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO-A: ACAT IC

OBJECTIVE: Develop a set of wideband apertures that cover 2 MHz to 2,000 MHz (or an appreciable percentage of that band) and a coupling concept such that the antennas may be used with the Joint Tactical Radio System (JTRS).

DESCRIPTION: The Department of Defense is developing a set of software defined radios known as JTRS. These radios will be capable of tuning from 2 MHz to 2,000 MHz. Each radio box will potentially be capable of simultaneously transmitting and receiving multiple signals over multiple bands. The software approach to the radio system and the amplifier technology are reasonably well developed. The methodology of coupling energy from the radios into the atmosphere is not as far along. The intent of this investigation is to develop an antenna or set of antennas that can support operation across the entire 2- to 2,000-MHz frequency band or a set of antennas that will provide coverage of major subsets of that band. Tuning mechanisms/matching circuits that will ensure good power transfer are a must, while an approach that allows multiplexing of signals on the antenna is also desired. The antennas/apertures shall efficiently support both transmit and receive functions. The concept should support future installation on subsonic Navy patrol aircraft. Applicability to all Navy aircraft would be ideal.

PHASE I: Develop an approach to solving the problem, show a design suitable for implementation, and support that design with a combination of theoretical analysis and experimental breadboards of critical components.

PHASE II: Develop a set of prototypes that could be mounted on an aircraft for static testing. Flight certified versions would not be required.

PHASE III: Develop a set of pre-production prototypes that can be flown on the P-3 and/or multimission maritime aircraft (MMA). At the successful completion of this phase, the antennas (antenna system) would be ready for production and installation on production aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A multifunction wideband antenna would be applicable to the cellular telephone industry for use on base stations of limited size by multiple suppliers. It would also be useful for public service radio systems that transmit on multiple frequency bands but have limited space for antennas.

REFERENCES:
1. "An Overview of the Joint Tactical Radio System." Available on line at http://www.jtrs.saalt.army.mil/, select "overview" from the home page.

2. "The Joint Tactical Radio System Software Communications Architecture (SCA)." Available on line at http://www.jtrs.saalt.army.mil/, select "latest SCA."

3. "Operational Requirements Document for JTRS." Available on line at http://www.jtrs.saalt.army.mil/, select "Archives" and then the ORD.

KEYWORDS: Multifunction Antennas; Software Radios; Wideband Antennas; Integrated Apertures; Tuning Mechanisms; Matching Circuits

N03-202 TITLE: <u>Combat System Automation Management</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate

OBJECTIVE: Develop and demonstrate a methodology for engineering human understanding into automated combat system processing.

DESCRIPTION: In today's combat systems, automated processing is designed to reduce operator workload and reduce systems response times in crucial situations. An example of this type of processing is Aegis Combat Systems Doctrine. Although theoretically beneficial, the results can be confusing to the human operator and contradictory to the original tactical intent. This is compounded by a user interface that is cumbersome, unforgiving, and not aligned to the warfighter's mental picture of the battlespace. Aegis Doctrine is but one example of this type of processing. What is needed is a set of tools and associated displays that will provide a "deep understanding" of the situation, as suggested in Weick's research into organizational "Sensemaking."

On future Navy ships, this problem will be compounded by significantly fewer sailors and increased use of automation. Additionally, as warfare systems become more integrated and common components and technologies become distributed across multiple platforms, the collaborative resource management of automated processing becomes even more difficult than with today's systems.

The effects of these trends on operational performance mandate that the systems used to manage automated processing conform with the warfighter's way of "thinking" about the battle space. Intuitive systems must be created to assist warfighter in identifying systems resource limitations, displaying alerts, sensor coverage, showing system resource conflicts, and weapons employment strategies all within the context of the battlespace. The need exists for tools to assist in the rapid human comprehension of the system-wide impact of proposed and actual changes to a ship's configuration. Such tools must address not only the interdependencies of related ship systems, but must convey the impact of system configuration changes upon mission effectiveness. The conceptual framework for such a set of tools has been demonstrated in efforts such as the Integrated Command Environment (ICE) program, which provides a state-of-the art use-case scenario for applications of human engineering technology.

PHASE I: Develop the requirements for management of automated combat systems processing within a reduced-manning CIC and aviation command and control nodes. Design, develop, and document a human-centered systems methodology for enhancing operator comprehension of the environment and for managing automatically controlled processing and resources both within and across platforms and integrated warfare systems.

PHASE II: Develop a prototype of the system described in Phase I. Develop a detailed design document for the combat system resource management tool prototype for potential transition to Phase III. Corresponding guidelines for use will also be delivered.

PHASE III: Produce and market the final system design. Develop design(s) for implementation into PEO IWS systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This methodology will have applications to military, government and private sector organizations in which automated processing controls system resources are used.

REFERENCES:
1) Hamburger, P. S. (2001), "Integrated Command Environment," CD-ROM publication, NSWC Dahlgren.
2) Weick, Karl E. (1995), Sensemaking in Organizations, Sage Publications
3) Evans, R., Fandozzi, J., Frangioso, T., et al. (1999), "Information Management Model," Mitre Corporation

KEYWORDS: Human-centered design; automation; display of automated processing; management of competing resources; combat systems doctrine

N03-203 TITLE: Human Performance Measurement Thresholds

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate

OBJECTIVE: Develop and demonstrate a methodology for assisting trainers in managing performance measurement requirements.

DESCRIPTION: Future Navy ships will be operated and maintained by significantly fewer sailors. Increasing use of automation, along with improvements in system reliability are behind this trend. The next generation of surface ships will increase their use of reliable automation resulting in the reduction of the number of personnel required to maintain and operate warfare/warfare-support systems. This reduction in manning also results in fewer trainers to manage the learning details of complicated systems. One important facet of making objective statements about performance to enable learning is human performance measurement. In some cases, performance measurement can be automated; however, certain situations and locations within the total ship environment require manual performance assessment. It becomes apparent that embedded/tightly-integrated training will be required.

With the wide range of tasks (cognitive and behavioral) being performed, trainers are often over-extended by the workload required to make observations. This is compounded by observations across multiple operators in short duration events covering multiple mission areas. The effects of this environment on training effectiveness, particularly embedded training methods and systems, are not well understood. Trainer workload management in this reduced manning environment will require new methodologies, since both the number of operators being trained and the training personnel available to conduct training will be reduced. Current training management capabilities, such as the Afloat Training, Exercise, and Management System (ATEAMS) and the Navy Training Information Management System (NTIMS) need to be extended to ensure individual competencies and supporting team behaviors can be assessed within the limitations of the training personnel available. The research and methodologies generated by this SBIR will lay the foundation for new training paradigms that will be effective in this type of environment.

PHASE I: Research training workload limitations for manual data collection. Identify strategies and techniques to prioritize trainer assets during the data collection planning process. Conduct workload experiments to obtain quantifiable results for trainer capabilities. Based upon the results and strategies for data collection and trainer workload management, design tools to support data collection planning and trainer assignments.

PHASE II: Develop a prototype of the system described in Phase I. Integrate this prototype into and existing training management paradigm. Develop a detailed design document for the data collection management capability for potential transition to Phase III. Corresponding guidelines for use will also be delivered.

PHASE III: Produce and market the final system design. Develop design(s) for implementation into other shipboard training systems (Total Ship Training Capability (TSTC), DD(X), LCS, LHA-R, CVN, LPD-17, etc.).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This methodology will have applications to military, government and private sector organizations in which trainers conduct training in a simulation-based training environment.

REFERENCES:
1. Dwyer, D. J., Oser, R. L., Salas, E., & Fowlkes, J. E. (1999). Performance measurement in distributed environments: Initial results and implications for training. Military Psychology, 11(2), 189-215.

2. Stretton, M. L., Johnston, J. H. & Cannon-Bowers, J. A. (1999). Conceptual Architecture for embedded team training management. Human/Technology Interaction in Complex Systems, 9, 87-120.

3. Oser, R. L., Cannon-Bowers, J. A. Salas, E., & Dwyer, D. (1999). Enhancing human performance in technology rich environments: Guidelines for Scenario-Based Training. In E. Salas (Ed.), Human/Technology Interaction in Complex Systems, (pp. 175-202).

4. "Decision Making in the AEGIS Combat Information Center," Hall, J. K., et. Al., I/ITSEC Proceedings, 1998.

5. ATEAMS Functional Description Document, Revision 5, December 8, 2000.

6. ATEAMS Core CONOPS, Revision 1, December 8, 2000.

KEYWORDS: Onboard Training; objective-based training; training management; Scenario Based Training, manual data collection, trainer support

N03-204 TITLE: <u>Fast Cure Primer and Non-Skid System and/or a Single Coat Non-Skid System</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aircraft Carriers, PMS 378, PMS 312

OBJECTIVE: Develop environmentally friendly and VOC compliant one or two coat "fast-curing" non-skid systems for use aboard U.S. Navy Ships, in particular, aircraft carrier flight and hanger decks. Non-skid systems are high performance, textured for slip-resistance, materials which are applied over steel or aluminum surfaces.

DESCRIPTION: Current non-skid systems (primer and non-skid topcoat) used on U.S. Navy ships are qualified and graded in accordance with MIL-PRF-24667 "Coating System, Non-Skid, for Roller or Spray Application." The present state of the art has evolved over many years of trial and error to the present state of non-skid coating materials science. Military uses of non-skid coatings include installation aboard aircraft carriers and auxiliary ship, bridges, aircraft, and a variety of other vehicles. About 4.5 acres of non-skid materials are used to coat an aircraft carrier flight deck. For present polymer technology, curing times for polyamide epoxy materials are time and temperature dependent. For non-skid primers they generally range from 4 hours for dry to touch to 12-36 hours for dry to overcoat. The time ranges are assumed to be at 70º F. Curing times for non-skid topcoats range from 12-36 hours to dry hard.

PHASE I: Establish feasibility of primer/nonskid system and/or single coat non-skid system process best suited to fabrication, assembly and maintenance of ships. Provide a comparison with current polymer non-skid coating systems along with a cost model of recurring/non-recurring expenses for the selected process/coating system.

PHASE II: Establish material infrastructure, application equipment and control systems for selected non-skid coating systems/process at the point of manufacturer and/or in maintenance facilities. Demonstrate application and curing properties in ship construction/repair environment. Ensure application and curing process does not adversely affect fire, smoke and toxicity requirements as well as material mechanical properties. Provide a set of recommended tests to include: Fire, Smoke and Toxicity (MIL-STD-2031; Mechanical properties (MIL-STD-1689). Finished coating characteristics, such as appearance of dried coating, application properties, chemical resistance, coefficient of friction, color, color deviation, flexibility, immersion resistance and impact resistance shall be as delineated within MIL-PRF-24667.

PHASE III: Implement selected primer/non-skid and/or single application non-skid processes into fabrication, assembly and maintenance of ships. Introduce technology to other agencies for application and installation aboard aircraft carriers, surface ships, auxiliary ship, aircraft, armored vehicles, and other land vehicles, and engineered structures where non-skid is appropriate.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has the potential for wide utilization in such diverse areas as marine structures/vessels, aircraft and support vehicles in areas of slip-resistant requirements, and other consumer products.

REFERENCES:
1. MIL-STD-2031, Fire and Toxicity Test Methods and Qualification Procedure for Composite Material Systems used in Hull, Machinery, and Structural Applications Inside Naval Submarines

2. MIL-PRF-24667A, Coating System, Non-Skid, for Roll or Spray Application

3. MIL-STD-1689, Fabrication, Welding, and Inspection of Ships Structure

KEYWORDS: non-skid; slip-resistance; steel; corrosion; protection; adhesion; impact resistance; fast cure

N03-205 TITLE: <u>Casualty Power Electrical System Status Monitoring and Reconfiguration Management</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO Aircraft Carriers, PMS 378, PMS 312

OBJECTIVE: Develop innovative concepts, technologies and methods to support intelligent electrical systems monitoring and reconfiguration techniques to include ship's installed electrical distribution system, casualty power and vital system restoration following shipboard casualties.

DESCRIPTION: Current and future ship classes are increasingly dependant on electrical power availability to support mission systems. Recent shipboard casualties have illustrated the ship's dependence on electrical power availability and the resultant effects of casualties on this availability based on extensive damage to the ship's electrical system infrastructure. These casualties have rendered ships unable to respond to subsequent attacks and have impacted the ability of the crew to properly respond to the casualty due to the unavailability of electrical power to vital systems. Casualty power cables and connections have been designed into certain ship classes to support the recoverability and restoration of electrical power to vital systems or to sections of the ship. However, training and familiarity in the use of the Casualty Power System have resulted in the system being improperly deployed or not used at all to respond to the electrical casualty. The system's inherent safety concerns result in inadequate training of the system's capabilities and uses. During a high stress casualty situation this lack of understanding of the Casualty Power and the ship's Electrical System infrastructure results in "Blackened Ship" conditions that require long periods of time to recover from, which makes the ship very vulnerable to additional attacks.

PHASE I: During Phase I, a system architecture will be identified that will provide a virtually real-time electrical power/system restoration scheme for a particular ship. This restoration plan will address the ship's primary mission and vital systems.

PHASE II: During Phase II, cabling and vital system data for a target ship will be collected and a prototype system will be developed to demonstrate the virtually real-time restoration plan to reroute/recover vital shipboard systems after a casualty has occurred.

PHASE III: During Phase III, the demonstrated system would be put into production, including the development and delivery of related documentation and an innovative and robust software tool that can be ported to the Navy fleet-wide ships for virtual real-time restoration planning to reroute/recover vital shipboard systems after a casualty has occurred.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This software has universal application to assist industrial plants and office buildings trace and recover vital system cable routing in the event of physical damage.

REFERENCES:

1) NWP 3-20.31 Surface Ship Survivability
2) NSTM 079 Volume 2 Practical Damage Control
3) NSTM 079 Volume 3 Engineering Casualty Control
4) NSTM 300 Electrical Plant – General
5) NSTM 310 Electrical Power Generators and Conversion Equipment
6) NSTM 320 Electrical Distribution Systems
7) NSTM 330 Lighting

KEYWORDS: Casualty Power; System Status; Electrical Casualty; Blackened Ship; System Reconfiguration; Real-time restoration.

N03-206 TITLE: Oil-in-Water Emulsion Breaking System for Bilge Water

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PEO Aircraft Carriers, PMS 378, PMS 312

OBJECTIVE: Enable U.S. Navy ships to break bilge water containing oil-in-water emulsions aboard ship.

DESCRIPTION: Bilge management practices have reduced the total volume of bilge water produced aboard U.S. Navy ships. However, this volume reduction has caused an increase in the concentration of the bilge water contaminants (oil, nonionic detergents, commercial laundry detergents, AFFF, cleaners, solvents, etc.) thereby creating higher concentrations of stable oil-in-water emulsions. The gravity treatment systems (OWS) currently installed aboard most Navy ships are not designed to treat these emulsions. Therefore, a system/process must be developed to treat or break oil-in-water emulsions. Historically chemical based emulsion breaking processes, though effective, have proven to be logistically unsupportable and untenable in a shipboard environment.

PHASE I: Develop a system/process to break oil-in-water emulsions. The system/process should be able to break oil-in-water emulsions in single or multiple stages to form stable oil droplets of 20 um or larger to allow the OWS systems to treat the bilge water to less than 15 parts per million (ppm) oil. Also, the selected technology and design must consider the limited shipboard space, utilities, Ship's Force, and be able to break oil-in-water emulsions in the presence of influent dissolved solids, suspended solids, a pH range of 3 to 9, and a wide variety of solvents, detergents and cleaning agents at process flow rates of 5 to 50 gallons per minute, typical of existing and projected future (dryer bilge) carrier OWS flows. Feasibility of the emulsion breaking system/process must be demonstrated through bench-top studies.

PHASE II: Design, test and evaluate the oil-in-water emulsion breaking system/process. The system/process must be evaluated in accordance with established testing protocols for shipboard environmental systems, using feedwater that is representative of U.S. Navy shipboard bilge water. A final report will be due at the completion of Phase II that includes a cost analysis to include ship installation.

PHASE III: After verifying the effectiveness and applicability of the method, develop and implement a strategy for transitioning the emulsion breaking technology into industry and to U.S. Navy ships for shipboard test and evaluation. This phase will include the preparation of required documentation, including a tech manual, MRC's, APL's and other ILS needed for shipboard operation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to any industry requiring oil-in-water emulsion treatment (i.e. cruise line industry, petroleum industry, etc.).

REFERENCES:
1. OPNAVINST 5090.1B, Chapter 19, Section 5.4
2. IMO MEPC.60(33)
3. 46 CFR 162.050

KEYWORDS: Emulsions; oil; bilge water; wastewater treatment; oil-in-water; flow rate

N03-207 TITLE: Tools for inter-component dependency identification and failure mode and effects analysis.

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMS 500, Design Integration, Safety, HSI

OBJECTIVE: Development of an innovative modeling and simulation approach and a supporting tool set that enables engineers to identify inter-component dependencies and analyze the failure modes and effects within a given system architecture.

DESCRIPTION: This topic specifically focuses on the use of inter-component dependency attributes to assist in fault tolerant design. Mission critical system development requires thorough architectural analysis, especially with respect to the complex inter-component dependencies and the failure modes and effects, to create a highly available system.

Modern systems, seeking to optimize reliability, availability, and affordability, are characterized by widely distributed, dynamically reconfigured system architectures relying on new COTS technology (such as the DD(X) Total Ship Computing Environment (TSCE)). The level of complexity in these new systems approaches tens of thousands of components allocated to thousands of execution hosts, which are dynamically reconfiguring into variable unpredictable configurations at sub-second periodicity. While these new, distributed, dynamically reconfigurable systems provide significant benefits in warfighting capability, availability, and total ownership costs, they present three significant problems in design, development and validation. These three problems are the current inability to analytically assess the validity of the complex architecture (tens of thousands of components), the difficulty in generating a fault tolerant design (hard to prove tolerance in the unpredictable dynamics) and the inability to apply current test and certification techniques (the system is always in state of flux).

In traditional fixed allocation systems, faults and failures are easier to define and to localize, rendering the fault tolerant design simpler due to the stable non-dynamic nature of the design. In the emerging widely distributed, dynamically reconfigured system architectures, such as the DD(X) TSCE, traditional methods to identify specific failure modes and effects, effects and analysis, and failure recovery techniques will not work. This is due to substantially increased complexity and unpredictability of the system configuration of the various sub-systems. Additionally, there is a lack of supporting concepts and processes to effectively model inter-component dependencies and reproduce representative dynamic execution allocation environments.

An innovative approach is needed to develop a method or a tool set which will identify the inter-component dependencies and analyze associated failure modes and effects for the hardware and software components which comprise a system's architecture. This approach and the supporting tools and methods shall focus on these reliability issues to make any given architecture more robust. The tool set shall focus on identifying and analyzing inter-component dependencies and resultant reliability / fault tolerant issues for complex systems with tens of thousands of components dynamically and variably allocated to thousands of host processors.

PHASE I: Demonstrate the feasibility of an innovative approach to address the identification of complex system inter-component dependency and failure analysis. The concept proposed will develop an inter-component dependency identification schema accompanied by the development of an analysis approach for the associated failure modes and effects. Develop a set of stimulus test cases to test the schema, analysis, and the associated tool set. Stimulus test cases should be representative of a highly distributed and dynamically modifiable execution environment with both parallel components and redundant instantiations of idle components

PHASE II: Develop and test the prototype tool set against the defined test cases in the hypothetical environment. Review the results with the Navy, revising both the approach and the tool set if appropriate. Finalize and validate the application of the approach and of the tool set to a distributed system test lab environment (with fault injection capabilities) to be approved by the Navy.

PHASE III: Working with the Navy, develop user-friendly packages for use by engineering firms in civilian and military domains. Specifically work with the DD(X) Design Agent to apply the approach and the support products to the full DD(X) system. Reiterate the application of approach and the supporting products throughout the critical design assessment and review cycles. Prepare product for use in other Navy systems such as the CG(X).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool set could be applied in engineering and communication environments where systems reliability is a concern. Applications could include but are not limited to automated assembly lines, commercial robotics, communication system domains, or even financial management systems.

REFERENCES:
1) www.sei.cmu.edu
2) www.cmu.edu

KEYWORDS: Analysis, Architecture, Fault Tolerance, Inter-Component Dependency, Software

N03-208 TITLE: <u>Tools for testing and certification of distributed, dynamic configurations of a total ship computing environment.</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PMS 500, Design Integration, Safety, HSI

OBJECTIVE: Development of an innovative approach with procedures and a supporting tool set which enables system and software engineers to quickly test and certify large complex, widely distributed, dynamic configurations of a system.

DESCRIPTION: This topic specifically focuses on test and certification. Complex, re-configurable, dynamic mission critical system development requires thorough testing and certification to verify that the system is safe and functions as implemented in accordance with specifications.

Modern systems, seeking to optimize reliability, availability, and affordability, are characterized by widely distributed, dynamically reconfigured system architectures relying on new COTS technology (such as the DD(X) Total Ship Computing Environment (TSCE)). The level of complexity in these new systems approaches tens of thousands of components allocated to thousands of execution hosts, which are dynamically reconfiguring into variable unpredictable configurations at sub-second periodicity. While these new, distributed, dynamically reconfigurable systems provide significant benefits in warfighting capability, availability, and total ownership costs, they present three significant problems in design, development and validation. These three problems are the current inability to analytically assess the validity of the complex architecture (tens of thousands of components), the difficulty in generating a fault tolerant design (hard to prove tolerance in the unpredictable dynamics) and the inability to apply current test and certification techniques (the system is always in state of flux).

Basic Testing and certification is currently accomplished explicitly by testing the fixed baseline configuration and any fixed redundant fall back configurations to meet survivability and availability requirements. This can be an expensive and time consuming process. In large, widely distributed, dynamically reconfigurable systems of the future (such as the DD(X) TSCE) the total possible number of configurations is practically unlimited. There is simply not enough time or funds to test and certify all potential, valid configurations using traditional test and certification methods.

Innovative approaches and new tools (procedures) are necessary to achieve the requisite certification and validity of critical systems. The approach, procedures, and tool set shall focus on testing and certification of distributed, dynamic configurations of a total ship computing environment for complex systems with tens of thousands of components allocated to thousands of host processors. These components are developed by different developers with potentially different processes and development procedures and vary in size and complexity from a complete functional legacy system (of 60,000 to 100,000 Source lines of code) to many small general service modules (from 200 to 1000 Source lines of code) or a simple Object template or SQL parser, and all points in between. It is recognized that new and modified practices may be necessary to implement the requested innovations.

PHASE I: Demonstrate the feasibility of an innovative approach to the testing and certification of large, complex dynamically configured systems. The concept proposed will analyze the proposed application of the supporting tool set against a hypothetical, complex distributed system with dissimilar component styles, sizes and structures. Develop a design for the associated toolset and propose a set of tests to exercise and evaluate the concepts, procedures, and tools. The proposed concept should address potential benefits to be gained and costs to be incurred when comparing the proposed approach to current explicitly exhaustive test methods.

PHASE II: Develop and validate the prototype toolset against the hypothetical system defined in Phase I. Review the process / concept with the Navy and revise as applicable. Actively participate with the DD(X) Design Agent to address the application of the methods and tools to the DD(X) TSCE Engineering Development Model (EDM) that are compatible with the developed approach.

PHASE III: Working with the Navy and/or industry, develop user-friendly packages for use by engineering firms in civilian and military domains. Reiterate the application of approach and the supporting products throughout the critical design assessment and review cycles. Prepare product for use in other Navy systems such as the next generation cruiser, CG(X)

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool set could be used in automation of testing and certification procedures of products for the commercial marketplace at a substantially reduced cost to the manufacturer. An example of this would be a reduction in the amount of beta testing required for software packages before they are released to the public.

REFERENCES:

1) www.sei.cmu.edu
2) www.isacc.com/isacc99/

KEYWORDS: Certification, Testing, Architecture, Dynamic Reconfiguration, Distributed.

N03-209 TITLE: SiC Power Converter

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: ACAT I: DD (X) PMS 510

OBJECTIVE: Develop a power converter based on SiC semiconductor technology capable of handling high currents and voltages.

DESCRIPTION: This topic addresses application of emerging SiC semiconductor technologies to power converters in the Advanced Gun System (AGS) which is a key system for the DD(X). Other applications for SiC converter technology include ship service power converters and actuator controllers. The AGS represents a significant electrical load during operation. One of the key enabling issues in AGS is size, weight and efficiency of the power electronics. Silicon carbide (SiC) based power electronics have the potential for reliable operations at higher junction temperatures and higher power densities than can be achieved with silicon (Si) transistor technology. SiC has the potential for up to a 5-fold reduction in converter volume if high temperature, high frequency power electronics can be implemented. The reduction in volume of the ship service drives and actuator controllers would provide increased flexibility in equipment arrangement.

The reason for the interest in SiC technology for high temperature and high frequency operation is that the overall system can be made smaller and more efficient. High frequency operation generally drives the value/size of the passive components in a system down. High operating temperature also allows a larger temperature difference between the heat sink and the operating fluid being used to carry away the heat, which will increase the radiator effectiveness and decrease its size. Silicon devices are limited to an operating temperature range of 150º C; whereas Silicon Carbide devices can safely handle temperatures of 200° C and higher. In addition, Silicon Carbide devices offer the potential for incorporating the drive electronics into the motor itself, resulting in an additional reduction in system cabling and volume.

Current SiC switches and diodes typically have a current rating less than 10A. To achieve, higher power levels, it will be necessary to parallel SiC die within a high temperature power module. The goal is to optimize the packaging of SiC switches and diodes to allow multiple SiC die to be paralleled within a power module. In particular, the packaged switches and diodes must be optimized for operation at not less than 200° C and must have short circuit withstand capability greater than 10 microseconds.

This topic seeks to produce the technology for high performance SiC power converters with power rating of 60kW with switching frequency of 100kHz or greater for a 450VAC bus using 1200V SiC switches and Schottky (or MPS) diodes with 200oC or greater maximum junction temperature. Air cooling of the power electronics is desirable but not necessary. SiC switches should be selected for normally-on vs. normally-off switch operation, current rating of > 10 amps, and reliable multiple die packaging approaches.

PHASE I: Demonstrate the feasibility of the development of a SiC power converter to support a 60KW converter for the AGS program. This assessment will include the use of in-house generated experimental data, literature search results, and/or appropriate analytical modeling. The concept should propose designs for normally-on vs. normally-off switch operation and should focus on multiple die packaging approaches. The concept should also address the availability of the 1200 volt SiC power switch. Provide design calculations as well as a preliminary cost analysis.

PHASE II: Fabricate and demonstrate a prototype power module based on SiC technology. For this power module,
characterize the switching frequency, power loss, output power, device operations temperature and EMI per MIL-STD-461. Upon completion, fabricate and demonstrate prototype 60KW SiC converter as described in Phase I utilizing the developed power module. Again, characterize the switching frequency, power loss, output power, device operating temperature and EMI per MIL-STD-461 and MIL-STD-1399. Working with the Navy and Industry, develop an insertion strategy. A commercialization strategy will be developed targeting the power electronics industry.

PHASE III :. Produce a full-scale converter, in conjunction with a phase III partner, for use in driving the AGS on flight 2 of the DDX. The converter would incorporate lessons learned from the Phase II and would be in compliance with the DDX ship specifications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Industries that will benefit from this technology are converters and actuator controllers industries. Other industries to benefit are the automobile, and aircraft industries that will be able to utilize smaller, lighter power converters in their all electric products.

REFERENCES:
Leon M. Tolbert, Burak Ozpineci, Syed K. Islam, Fang Z. Peng, "Impact of SiC Power Electronic Devices for Hybrid Electric Vehicles," 2002 Future Car Congress Proceedings, June 3-5, 2002, Arlington, Virginia. (SAE Paper Number 2002-01-1904). http://www.ece.utk.edu/~tolbert/pubs.htm

P. Alexandrov, J.H. Zhao, W. Wright, M. “Inductively-loaded half-bridge inverter characterization of 4H-SiC merged PiN/Schottky diodes upto 230A and 250C, Electronics Letters, Vol. 37, pp.1261-1262, 2001

B. Allebrand and H.-P. Nee On the possibility to use SiC JFETs in Power Electronic circuits, 9th European Conference on Power Electronics and Applications. EPE 2001. Brussels, Belgium: EPE Assoc, 2001. p. 9 pp..

B. Allebrand and H.-P. Nee, Minimizing oscillations in the Diode-Less SiC JFET Inverter Bridge,”
“On the choice of blanking times at turn-on and turn-off for the diode-less SiC JFET inverter bridge.” 9th European Conference on Power Electronics and Applications. EPE 2001. Brussels, Belgium: EPE Assoc, 2001. p. 10 pp. Conference Paper

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KEYWORDS: SiC, Power Converter, power switch, power diode, high temperature, high frequency

N03-210 TITLE: <u>Human Systems Integration in Netted Systems: Support for Watch Turnover</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO Ships

OBJECTIVE: To establish consistency and efficiency in the shipboard watch turnover process through application of HSI design principles and leveraging netted information available to combat software systems.

DESCRIPTION: The increasing technical complexity of naval warfare presents a challenge to system designers charged with fielding integrated, netted, warfare systems that meet key performance parameters related to manpower, training, and human performance metrics. In addition, the increasing bandwidth available to shipboard operators and decision makers has resulted in an ever-growing volume of data in need of processing and assimilation by tactical decision makers. Not only is there a need for rapid processing of this data into usable information by shipboard decision makers, but also there exists a concomitant need for oncoming watch personnel to rapidly develop a situational awareness of the tactical environment about which a great volume of data has been compiled during the previous watch.

Current watch turnover preparation techniques practiced in the fleet involve a face-to-face, ad hoc collection of information from locations throughout the ship. This is time-consuming, inconsistent, and woefully lacking in its ability to generate consistently accurate situational awareness. The human performance impact of continuing current practices will result in a critical decline in knowledge superiority during the early minutes, or hours, of an on-coming watch, while relieving personnel attempt to absorb the current tactical situation and develop a shared mental model of the current environment in which the ship is operating.

Therefore, it is important to develop systems that will ameliorate the negative conditions associated with watch turnover in a high tempo, high bandwidth, network-centric warfare environment. In netted systems, this ‘watch team’ may not be co-located on one naval platform, which in and of itself can impact the quality of any ‘face-to-face’ turnover. The Navy need is for a system capability or capabilities that will assist oncoming watch personnel in the rapid assimilation of information related to the operating conditions under their cognizance or that will impact their watch responsibilities. This has not been feasible in the past because so much information was not electronically available within the ship’s systems. Current systems under development as well as future systems will have most this information already captured electronically; however, no plans currently exist to process that information into a usable format for watch turnover.

The key of any proposed method or system will be the fusion of information required for a watchstation that is presented in a manner best optimized for learning and situation awareness. The proposed method will address the development of an operational concept as well as the architectural requirements necessary to support the presentation of information from disparate sources. For illustrative purposes, this method shall address the Tactical Action Officer (TAO) operator development of situation awareness related to 1) system knowledge, 2) personnel knowledge, 3) tactical events, and 4) shared understanding of operational conditions in the environment by other members of the watch team in which he will function. While the ultimate goal is a turnover system in an Enterprise Watch Team, the initial effort will focus on TAO’s aboard the same platform and will focus on the concept of retrieving information from both onboard and off-board (netted) systems.

PHASE I: The awardee will demonstrate the feasibility of the proposed concept by placing within the context of a Tactical Action Officer (TAO) watchstation as defined in the description. The awardee will further propose testing parameters to be used to demonstrate capability under Phase II.

PHASE II: Develop a prototype watch turnover support system, which supports dynamic information flow from tactical systems and/or simulation/stimulation feeds. Conduct controlled testing of the prototype. Validation testing will include the collection of baseline data from existing systems (i.e., manual watch turnover techniques) as well as testing of the prototype under laboratory conditions at a government facility defined by the government in collaboration with the awardee.

PHASE III: Working with the Navy, address the process for extending the capability to additional watchstation roles and across Naval platforms in an Enterprise Watch Team. Phase III will incorporate the watch turnover support capability into funded Navy systems as defined by the Navy. This development path will include the final architecture and design and necessary testing. Commercialization opportunities, based on design/investigation rules, with regards to other shift-work based operator roles in other DoD and industrial environments will also be investigated. Successful Phase III transition may include either a watch turnover system onboard a single vessel or a turnover systems in separate, netted systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The same human performance issues associated with sea-based watch rotations are relevant to industrial work environments in which workers face rotating shifts and the need to maintain situation awareness of complex systems in enterprise teams. Other shift-based job roles with heavy cognitive loading, such as air traffic control, could benefit from automated system capabilities that permit the rapid and accurate transfer of situation awareness between on-coming and off-going shift personnel.

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2) Winters, J. J. & Dugger, M. "Watch Turnover Support for Future Surface Combatants." Presented at ASNE 2001, Human Systems Integration Symposium, Arlington, VA, 5-6 Nov. 2001.
3) Chavez, L., Winters, J.J., Hildebrand, G.A., and Wallace, D.F., Situation Awareness in the CIC: Automated Watch Turnover, Tactical Symbology, and Situation Assessment Tasks, NSWCDD/TR-02/48, submitted for publication, NSWC Dahlgren, VA.
Key words: human performance; situation awareness; knowledge superiority; watch turnover; shipboard operator; cognition

KEYWORDS: human performance; situation awareness; knowledge superiority; watch turnover; shipboard operator; cognition

N03-211 TITLE: High Damping Resin for Impregnation of Propulsion Scale Electric Machinery

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT I: DDX; PMS 510,

OBJECTIVE: Develop a high damping polymer resin that can be impregnated into electric machine stator and rotor core structures to reduce their resonant response for reduced noise operation. The material will replace conventional materials that are currently not optimized for damping performance.

DESCRIPTION: Electric motor stator and rotor structures are electro-magnetically (EM) driven in a myriad of configurations to provide motive power. Due to the normal imperfections in electrical drives and physical arrangements, the same forces that propel the moving elements of a motor can also drive the structure to produce undesirable structureborne noise. An example of this is the 2E 120Hz hum which emanates from common AC consumer motors. If the forcing frequencies coincide with motor resonances with low damping, the structural response can be amplified and significantly higher noise levels will result. Generally, for simply driven machines designed to operate at fixed speeds, it is possible to design the primary motor structures so that fundamental resonance frequencies are different from the various simple forcing frequencies. This is one method for producing machines with relatively low structureborne noise. For large variable speed/frequency drives with complex and imperfect waveforms, it is not practical to design the structures with complete resonance avoidance of all the possible forcing functions. For these cases, use of highly damped motor structures will be beneficial to reduce the response and thus structureborne noise where coincident resonances occur.

The goal of this topic is to develop a high damping polymer resin to replace the materials currently used to impregnate motor core structures. A polymer resin is considered to have a high damping characteristic when its loss factor is not less than 0.75, between the temperatures of 80°C and 120°C. Impregnation resins play a significant role in determining the modal damping of the overall structure; however, current materials are not formulated to optimize damping performance. The concept proposed should utilize Dynamic Mechanical Thermal Analysis (DMTA) to verify the level of damping in the polymer resins proposed. The rheological parameters that should be used in screening for enhanced damping capability include but are not limited to: loss factor, glass transition, damping factor, complex viscosity and complex modulus. The proposed polymer resins must also have similar physical and dielectric characteristics of conventional impregnation materials in addition to the required high damping performance. Conventional physical characteristics include thermal conductivity, dielectric strength, adhesion, and environmental sealing (as described in Military Specification MIL-I-24092D or NEMA RE-2). The proposed polymer resin must be compatible with conventional VPI methodology and hardware, as VPI is the current process used in the manufacture of large motors. The new polymer must also exhibit toxicity and environmental or handling hazards no greater than those of existing polymers.

Verification of the performance of the high damping impregnation polymer will be conducted using two 15-20 kW induction motors, powered by a variable speed/frequency pulse width modulated (PWM)drive, operated under a variety of loaded test conditions as defined by the Navy. Prior to testing the stator, one motor should be impregnated with a polymer resin, as approved by the Navy, that does not have a high damping characteristic. The other stator should be impregnated with the high damping polmer resin. Parameters that should be measured in both motors are structureborne noise per MIL-STD-740, and temperature rise by resistance per IEEE 112.

PHASE I: Demonstrate the feasibility of the proposed concept for a high damping polymer resin for motor impregnation. The concept feasibility should be supported by in-house generated experimental data, literature search results, and/or appropriate analytical modeling. The proposer will identify projected safety concerns associated with the concept as applicable.

PHASE II: Formulate a high damping polymer resin for motor impregnation and demonstrate on a laboratory test sample level the performance obtained. Using Dynamic Mechanical Thermal Analysis (DMTA), demonstrate the damping performance improvement over existing materials. Conduct comparisons of the two machine stator configurations and obtain structureborne noise and temperature rise by resistance data.

PHASE III: The small business shall work with the Navy and industry in the implementation of this high damping impregnant on a full scale propulsion motor (>30 MW). As appropriate, the small business will work with Industry and motor manufacturer(s) to leverage this technology for DD(X) or other platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector commercial motor manufacturers could use this technology for producing lower noise electric machines of any scale.

REFERENCES:
1. S.P. Verna, A. Balan, Experimental Investigations on the Stators of Electrical Machines in Relation to Vibration and Noise Problems, IEE Proceedings Electrical Power Applications, Vol 145, No.5, September 1998

2. S. Watanabe, s. Kenjo, K. Ide, F. Sato, M. Yamamoto, Natural Frequencies and Vibration Behavior of Motor Stators, IEEE Transactions on Power Apparatus and Systems, Vol PAS-102, N0. 4, April 1983

3. S. Noda, S. Mori, F. Ishibashi, K. Itomi, Effect of Coils on Natural Frequencies of Stator Cores in Small Induction Motors, IEEE Transactions on Energy Conversion, Vol. EC_2, No. 1, March 1987

4. C.T. Sun, Y.P. Lu, Vibration Damping of Structural Elements, Prentice Hall, Englewood Cliffs, NJ, 1995

5. MIL-I-24092D, “Military Specification – Insulating Varnishes and Solventless Resins for Application by the Dip Process”, 21 September 1993

6. NEMA RE-2 1999, Electrical Insulating Varnish

7. MIL-STD-740-2, Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment

8. IEEE 112 1996, IEEE Standard Test Procedure for Induction Motors and Generators

KEYWORDS: Damping; noise; vibration; motors; impregnation; electric

N03-212 TITLE: Plug and Play for Combat Electronics

TECHNOLOGY AREAS: Sensors, Electronics

ACQUISITION PROGRAM: ACAT I: PMS 500, DD(X) Program Office,

OBJECTIVE: The objective of this topic is to develop and demonstrate an extended plug and play architecture using different electrical interface types to enable combat, weapon and sensor systems, whose hardware and software systems work together, to automatically configure devices, assign resources, and collect life-cycle usage data to support life-cycle support engineering analyses.

DESCRIPTION: Commercial electronics technology refresh cycles rapidly outpace those of military electronics, complicating the life-cycle support of hardware and software. Additionally, root cause failure analysis of electronics is complicated by the inability of host combat electronic systems to automatically record and maintain part usage/lifetime by serial number.

This topic seeks to reduce life-cycle costs through simplified supportability and maintainability. As with personal computers, the goal is to have the capability to plug in a new device and immediately be able to use it without the user having to complete a complicated setup procedure. Proposals to this topic should look beyond the Peripheral Component Interconnect (PCI) bus standard to accommodate other standard and non-standard bus-types and electronic circuit card interfaces. The proposal should address the development of the capability of devices to provide configuration and life cycle information (eg., part serial number, hardware/firmware revision, calibration data) to a host system. This would allow the host system to automatically load device drivers, perform any necessary system calibration and record part usage data for the purpose of calculating part-lifetime. Data of this nature will be useful for performing life-cycle support engineering analyses such as failure analyses.

PHASE I: Conceptualize and design an extended plug and play architecture to encompass other standard and non-standard interfaces besides PCI. Address the definition of an extensible message format so plug-ins may identify themselves for subsequent automatic configuration. The concept proposed should explore the addition of other interface messages/words to convey useful configuration, calibration, and life cycle support parameters across the interface. Propose measures of effectiveness to be used to demonstrate capability in Phase II.

PHASE II: Develop and validate computer program and hardware standard(s), interface specifications and other controlling/descriptive documents to communicate the concept and architecture. The small business will work with the Navy to define a demonstration environment based upon a COTS component representation of a combat sub-system. A prototype will be fabricated and tested at the small businesses facilities to validate the proof of concept using the demonstration components. Prototype performance will be measured to verify the design's compliance to developed standards and specifications, across a range of interface types.

PHASE III: Working with the Navy and Industry, the small business will transition the design concepts and architecture to the DD(X) Design Agent for DD(X) combat electronics designs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This concept is applicable to commercial electronic systems with life cycles similar to military electronic systems i.e. long lifetimes, frequent technology refresh cycles, and frequent service. Specific applications could include but would not be limited to avionics and super-computers.

REFERENCES:
Typical PnP Specification
1. http://www.upnp.org
2. http://www.microsoft.com/hwdev/
Universal Serial Bus Revision 2.0
3. http://www.usb.org
Firewire IEEE 1394
4. http://www.ieee.org

KEYWORDS: Electronics; Interoperability, Universal Plug and Play

N03-213 TITLE: Firmware Analysis Test System

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate IWS

OBJECTIVE: Enable engineering and technical personnel to inspect and analyze firmware-controlled instructions, algorithms, and data transfers within complex electronic systems designed with multiple processing units.

DESCRIPTION: This system, if developed, will allow more comprehensive analysis of systems with regards to maintenance and troubleshooting in the fleet. It allows the Navy to improve performance of fielded systems at current or reduced infrastructure cost performance. Technological advances in embedded microprocessor design have caused an increased transition away from systems that utilize hardware designed to perform a specific task and towards processors programmed to perform multiple functions through embedded firmware. Although this provides greater flexibility in implementing modifications and upgrades to the system it hinders the ability of the engineer or technician servicing the fleet from analyzing problems and anomalies that are firmware related. Due to the nature of these systems there is rarely, if ever, any built-in capability to collect and record internal real-time data processing and data transfers for analysis of equipment problems in the fleet. Also, such systems may utilize "virtual" test points in the development of their fault isolation capabilities as opposed to traditional hardware test points that could be observed and analyzed through the use of test equipment (e.g., oscilloscopes and logic analyzers). Such virtual test points are maintained and checked through firmware and therefore require the ability to observe and analyze this test point data that is generated within the processors when resolving problems or anomalies.

Therefore, in order to meet the in-service engineering support requirements that systems such as these will require, a device or tool must be developed that provides the engineer or technician an ability to view/observe/analyze the firmware instructions and data while it is retrieved, processed, and transferred in real-time. This analysis tool must be portable and easily installed. The interfaces must be adaptable/universal, non-intrusive, require no modifications to the systems hardware configuration and have no affect on the current systems operation or operating systems. The test set must be capable of handling data bus transfers that are both synchronous and asynchronous. It must be capable of being easily modified for systems that utilize source code written in various languages (MIL-STD 1750A, C++) and operating systems (UNIX, VxWorks). The device must have the capability to record and store observed data for further analysis in both integrated and standalone mode. During analysis the user must be able to view both data/information and corresponding firmware instruction simultaneously. Ideally, the test system program should be able to reside on any COTS laptop computer with an accompanying hardware to provide the necessary interfaces to the system under test.

PHASE I: Develop a system design for a Firmware Analysis Test System using the AN/SPY-1D(V) radar as the candidate system under test, specifically the Signal Processor and Beam Steering Controller components. The test system should define/incorporate: the operating systems and firmware languages the test system can be modified for, the interfaces the system will utilize, the ability to view processor data and firmware instruction simultaneously, the graphical user interface, user capabilities, and test system options.

PHASE II: Design, fabricate, and operationally test two (2) first article proof of concept units. The proof of concept shall demonstrate the ability to view and analyze processing data and firmware instructions in real-time simultaneously. The Phase II effort shall validate the proof of concept, define a production set of hardware, software and firmware for a Phase III effort.

PHASE III: Transition to commercial markets and non-SBIR funded status through the sale of derivative proof of concept units to private corporations and government agencies who own, operate, or maintain complex electronic systems that rely heavily on multiple processors with embedded firmware instructions. Wireless telecom base stations would be prime example for commercial use of a firmware analysis test system. While the processing requirements may differ from those of a radar system they implement multiple embedded processors with a limited amount of test points for fault monitoring.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector costs for maintaining complex electronics systems that rely heavily on firmware to implement system functions are not unlike that of the government. Providing a tool that can provide accurate and reliable real-time data collection and firmware analysis capability to troubleshoot systems problems will reduce equipment downtime and increase its availability. System downtime for commercial ventures is costly and non-productive.

REFERENCES:

1. Stuart R. Ball. Debugging Embedded Microprocessor Systems. Butterworth-Heinemann, 1998
2. Bart Broekman and Edwin Notenboom. Testing Embedded Software. Addison-Wesley, 2002
3. Martin Fowler, Kent Beck, John Brandt, William Opdyke, and Don Roberts. Refactoring: Improving the Design of Existing Code. Addison-Wesley Publishing, 1999.
4. Jef Raskin. The Human Interface: New Directions for Designing Interactive Systems. Addison-Wesley Publishing, 2000.

KEYWORDS: Embedded source code; portability; universality; analysis; real-time; data collection

N03-214 TITLE: Multi-Axis Fiber Optic Strain Sensor and High-Speed Multiplexing System.

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO Surface Ship Weapons/Launchers Directorate (IWS-3.0), Missile Systems

OBJECTIVE: To develop a high-speed multi-axis fiber optic strain sensor and associated high-speed multiplexing system that provides means to monitor three-dimensional strain on a single fiber optic line in missile canisters and missile bodies without electrical hazards.

DESCRIPTION: In order to continually monitor environmental exposure conditions of high-value missiles while in storage, during transport, and while in combat readiness conditions on Vertical Launch capable ships, there is a need to be able to measure and record three dimensional (x, y, & z axis) strain at frequencies of at least 1,000 Hz. The system should have a sampling rate of at least 5000 Hz. This high sampling rate will enable the Navy to help identify the sources of missile damage caused by high-frequency environmental shock and vibration. The fiber optic unit should provide electrical isolation from the multi-axis fiber optic sensor to the receiving and multiplexing portion of the system, to avoid any possibility of electrical charges or inadvertent ignition of rocket propellant or other explosive or electrical sensitive missile components. The capability of incorporating at least six (6) individual multi-axis sensors along a single line on one channel is essential. This is to minimize the number of individual fiber lines entering a missile container and missile body. The system should be able to multiplex a group of at least eight (8) separate fiber optic channels. On each channel the fiber optic line must be able to support a minimum of six (6) individual multi-axis sensors in series. In this configuration, the sampling frequency of each individual multi-axis sensor should be at least 5,000 Hz. These sensors will need to last the entire life-cycle of the missile. Environmental exposure ruggedness, which is the ability to withstand a wide range of temperatures, humidity, vibration, and shock are essential.

PHASE I: Conduct experimental efforts to provide a proof of concept demonstration of a high-speed three-axis fiber optic strain sensor and associated high-speed multiplexing System, which can be used for measuring and recording shock and vibration.

PHASE II: Develop a prototype fiber optic sensor that can monitor high-speed multi-axis strain suitable for incorporation into a missile canister and missile body. Demonstrate that the prototype system can support multidimensional strain measurements, while multiplexing multiple fiber optic channels. Each sensor, along a single fiber optic line containing multiple sensors, must have a minimum sampling frequency of 5,000 Hz.

PHASE III: Conduct engineering and manufacturing development, tests and evaluations, and system hardware qualifications for incorporation into existing and future missile programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The proposed technology will have a high level of interest to support a variety of aerospace platforms where strain history monitoring is important. It can be useful for monitoring shocks on trucks, ships, weapon systems, bridges, aircraft, cranes, and other equipment and structures where measurement of high-frequency multidimensional strain is required.

REFERENCES:
1. E. Udd, W.L. Schulz, J.M. Seim, A. Trego, E. Haugse, P.E. Johnson, “Use of Transversely Loaded Fiber Grating Strain Sensors for Aerospace Applications”, SPIE Proceedings, Vol. 3994, p. 96, 2000.
2. E. Udd, W.L. Schulz, J.M. Seim, E. Haugse, A. Trego, P.E. Johnson, T.E. Bennett, D.V. Nelson, A. Makino, “Multidimensional Strain Field Measurements using Fiber Optic Grating Sensors”, SPIE Proceedings, Vol. 3986, p. 254, 2000
3. D.V. Nelson, A. Makino, C. Lawrence, J. Seim, W. Schulz, E. Udd, “Determination of the K-Matrix for the Multi-parameter Fiber Grating Sensor in AD072 Fibercore Fiber”, SPIE Proceedings, Vol. 3489, p. 79, 1998

KEYWORDS: Fiber Optics; Sensors; Strain; Vibration; Shock; Multi-axis

N03-215 TITLE: Wideband Digital Beamforming and Direction Finding

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO Integrated Warfare Systems Electronic, Warfare Directorate IWS 4.0

OBJECTIVE: With the availability of wideband digital receiver suites for Electronic Support (ES), devise an efficient digital processing system for ES radar signal data parameterization, interference cancellation, and precision direction finding (DF).

DESCRIPTION: Wideband digital receivers are becoming practical for ES radar signal data parameterization. To fully exploit the digital capability of wide bandwidth, high dynamic range, and pulse on pulse data measurement, new digital signal processing architectures are required. Such architectures may be based on Field Programmable Gate Arrays (FPGAs) or other digital components that have the capacity to provide high capacity streams of pulse data words for ES processing.

Of particular importance, digital signal processing could provide significant advances in operability by enabling interference cancellation of unwanted platform signals and precision DF of desired radar pulses. The ultimate goal of this SBIR is to advance ES implementations on emerging Commercial-Off-The-Shelf (COTS) digital processing technology with a spiral development effort to implement the advanced ES algorithms for radar pulse parameterization and DF.

PHASE I: Investigate enabling technologies and COTS digital signal processing components that can be assembled into efficient ES processing architectures capable of providing pulse description measurements (PDM), interference cancellation (IC), and precision DF (PDF). Consider trade offs such as size and data handling capacity of FPGAs, the size and topology of data routing fabrics, and the balance between dedicated digital signal processor components and general purpose computing components to achieve the above PDM, IC, and PDF goals. Use the trade-off study to provide detailed prototype designs to guide the Phase II activity. Conduct proof of principle experiments.

PHASE II: Use the findings established in Phase I to develop, demonstrate, and deliver a laboratory brassboard that meets performance specification outlined above. The brassboard may represent a portion of an ES band with a representative ES antenna array, but the design and implementation must show that the digital signal processing architecture is clearly scalable with acceptable cost factors.

PHASE III: An anticipated Pre-Planned Product Improvement (P3I) around FY05 would require such wideband receivers for field applications. Transition new receiver technology into Navy and Coast Guard surface combatant ES systems. Other applications include Subsurface, Large Aircraft, and Aerostat platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Efficient signal processing and interference cancellation is applicable to many military sensing systems and to the commercial wireless and communication industry.

REFERENCES:
Andraka, R. and Berkun, A., "FPGAs Make a Radar Signal Processor on a Chip a Reality", Proceedings of the 33rd Asilomar Conference on Signals, Systems and Computers, October 24-27, 1999, Monterey, CA.

KEYWORDS: wideband; receivers; radar; EW; ES; DSP; interference cancellation; direction finding.

N03-216 TITLE: Total Ship Management System (TSMS) Operator Assistant

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate IWS

OBJECTIVE: To develop innovative technologies for Total Ship Monitoring System (TSMS) operators by improving performance and reducing workload.

DESCRIPTION: TSM systems to be installed on submarines include extensive acoustic sensor networks to detect radiated noise. TSMS currently produces and archives a vast quantity of signal and noise data, much of it intended for expert analysis ashore. This data would have immediate operational value to submarine crews if it could be analyzed on board. Feedback from Navy operators indicates that better analysis and interpretation of TSMS data is needed for Fleet technicians, who are not signal analysts or platform noise offender experts. The Fleet has also emphasized the importance of minimizing the requirements for intensive operator interaction. In addition, the operator's ability to interact with shore based analysis and support activities is limited. An innovative, automated data analysis and interpretation system is needed to make use of the wealth of TSMS data while minimizing the operator's required skill level and workload. Proposed techniques should extend beyond TSMS's current noise identification and localization capability by the incorporation of expert systems, connectivity with shore based analysis facilities, improved displays and operability, capabilities for noise offender identification, transient signal classification, or identification of changing signature trends.

PHASE I: Define a system concept for a TSMS operator assistant system and make the case for its feasibility and concept of operations. Implement critical components of the proposed technology and demonstrate the practicability of the methodology.

PHASE II: Implement a full software prototype of the system and demonstrate feasibility.

PHASE III: integrate the successful operator assistant subsystem into the TSMS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: opportunities exist to deploy the technologies resulting from` this innovation in commercial areas including machine condition monitoring, telemedicine, remote traffic monitoring, and remote learning.

REFERENCES:
1. Kil, D. S. and Shin, F. B., Pattern Recognition and Prediction with Applications to Signal Characterization, American Institute of Physics Press, Woodbury, NY, 1996

KEYWORDS: TSMS; data management; data fusion; software automation; intelligent tutoring

N03-217 TITLE: Conformal X-Bank Seeker for Semiactivee Guided Projectile

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: PEO Integrated Warfare Systems Surface Ship Weapons/Launchers Directorate

OBJECTIVE: Develop a conformal X-band antenna for use as a semiactive seeker for a guided gun projectile, intended for use with Aegis AN/SPG-62 illuminators against asymmetric surface and air threats such as small boats, light aircraft, and UAVs.

DESCRIPTION: This topic seeks the development of a technique for providing semiactive guidance for gun projectiles against surface and air targets. The key to this development is the demonstration of a conformal X-band antenna that provides angle rate measurement-to-reflected energy from the target to support proportional navigation-to-intercept. Low cost is a key requirement for this antenna and a conventional phased-array beamforming approach may be unaffordable in a projectile. However, designs that use a fixed antenna pattern or a small number of switchable patterns could be combined with the projectile's own roll rate to provide a lower cost solution. Reference 1 provides an analysis of one such integration.
The antenna must be conformal to the projectiles forebody; either to the Mk 64 projectile's ogive shape or to a conical shape. The ogive is preferred because of its greater volume and because the use of a conical projectile would require a sabot. The antenna must survive gun launch shock (26,000 g, where g = 9.8 m/sec2) and pressure. The antenna in combination with the projectile's autopilot and the illumination from the SPG-62 illuminator should be capable of guiding the projectile to within 10 meters of the target. The guidance technique used may assume the projectile has a suitable control system to respond to guidance commands and it has a pitch, yaw and roll reference such as micro-machined gyros aligned to a three-axis magnetometer (which leaves one degree of freedom in alignment).

PHASE I: Demonstrate the feasibility of the development of a design concept for a conformal X-band antenna for use as a semiactive seeker for a guided gun projectile. Simulate its performance in the defense against patrol boats at 10 km range and against light aircraft and UAVs at 20 km. Conduct any critical bench-scale hardware tests to assess the uncertainties, risks, and payoffs of the technologies selected. Characterize the performance of the antenna's components itself and the suitability of any novel materials being considered for the antenna, its structure, feed, or the radome.

PHASE II: Fabricate a prototype of the seeker head. Demonstrate its performance through captive carry tests and working with the Navy, demonstrate its ability to withstand a load of 12500 g's, though air-gun, centrifuge, or canister launches using commercial or government facilities, e.g. the NSWC Dahlgren 8-inch test canister.

PHASE III: The payload will be integrated into a guided projectile based on the ERGM or ANSR baselines. The Phase III effort will include integration and assessment of performance in range testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The approach to producing a selective, calibrated antenna pattern needed for this application also applies to commercial X-band requirements including highway speed measurement and "smart cruise control" use.

REFERENCES:

1. Investigations of Naval applications of the SSPG [Small Spinning Projectile Guidance] Concept—Final Report. W.J. Schafer Associates, Inc. and TG&C Associates, Inc., Delivery Order 1001, ONR Contract N00015-92-D-0136, 8 March 1994.

2. Drawing 53711-7243783, Critical Item Fabrication Specification MK 64 Mod 3 5-Inch 54 Caliber Project Body Assembly WS-32811

3. Mk 92 All-Up Round Ammunition Fact Sheet http://peos.crane.navy.mil/pdfs/MK%2092%20BL-P.pdf (The Mk 92 all-up round is a projectile that uses the Mk 64 body.)

KEYWORDS: semiactive; radar; guidance; conformal; tracking; seeker

N03-218 TITLE: Laser Designtor for Mk 46 Optical Sight System

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: PEO Integrated Warfare Systems Surface Ship Weapons/Launchers Directorate

OBJECTIVE: Develop a laser designator for the Mk 46 Optical Sight System (OSS) and for a follow-on optical sight system planned to replace the Mk 86 Gun Fire Control System's Remote Optical Sight. The laser designator will be for use in Anti-Surface Warfare and Ship Defense missions and secondarily for short-range Naval Surface Fire Support missions.

DESCRIPTION: Combat operations in the last ten years have shown the value of semi-active laser guidance to direct low cost weapons to precise aimpoints. Semi-active laser guided gun projectiles such as the Navy Deadeye have been developed, but ships are not currently equipped with laser designators integrated into their combat systems. However, the Mk 46 OSS provides an upgradable "T-Bar" design. A designator for this system's next upgrade is desired. This topic seeks application of newer electro-optic materials and mechanisms to provide a designator that includes the following advanced features (beyond current Nd:YAG designators):

· Eye safe operation without reduction in performance (current Nd:YAG designators are not eye safe and when made safe with non-linear optics suffer reduced range)
· Simplified or automatic bore-sighting
· High duty cycle operations. For example, the designator must be able to sequentially designate 10 or more incoming small craft, continuously designating for 10 minutes.
· Low-maintenance features, such as a solid-state light pump and air cooling
· Elimination of mechanical components and limited-life components such as Raman cells.

If possible, the designator should fit inside one of the Mk 46's lobes. If an eye-safe designator requires more room than currently available inside a lobe, the addition of a third lobe is permissible if deemed necessary to make the difference between an eye-safe and a non-eye-safe designator. The designator should have enough power and beam quality to designate any sea surface target visible to the Mk 46's TV or thermal imager. It should operate to the visible horizon in clear weather and to same limit of visibility as the imaging sensors in restricted visibility.

PHASE I: Demonstrate the feasibility of the development of a designator including optics, laser source, and supporting electronics. Conduct an analysis of its expected performance in scenarios typical of the Anti-Surface Warfare and direct fire Naval Surface Fire Support missions. The ASuW mission should focus on short-range ship defense mission against patrol boats or smaller craft where the ship is both the firing and illuminating platform. Conduct any critical bench-scale hardware tests needed to assess the uncertainties, risks, and payoffs of the technologies selected. Characterize the performance of the sensor itself and the suitability of any novel materials or mechanisms being considered for the optics, electronics, or the mounting.

PHASE II: Fabricate a prototype of the illuminator. Working with the Navy demonstrate its performance including beam power-on-target, boresighting accuracy, and high-duty-cycle capability.

PHASE III: The designator will be integrated into the Mk 46 sight as part of an upgrade currently planned for FY04 procurement and FY06 delivery. The Phase III effort will include integration and assessment of performance at sea.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lasers in the same power range as this designator are currently used in industrial processes for marking and fabric cutting. Both industrial lasers and this designator must address the impact of heat from high duty cycle operation on beam quality.

REFERENCES:
1. Mk 34 Gun Weapon System Fact Sheet http://peos.crane.navy.mil/pdfs/MK%2034%20Mod%200%20GWS.pdf
2. MK 46 Optical Sight System Focus Sheet
3. Mk 46 Optical Sight Prime Item Development Specification

KEYWORDS: laser; designator; semiactive; guidance; electro-optics; tracking; seeker

N03-219 TITLE: Minimum Bandwidth Distributed Simulations for Warfighter Shipboard Training

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate

OBJECTIVE: Develop techniques to employ legacy simulation in a manner that minimizes required communications bandwidth.

DESCRIPTION: Simulations can be designed to optimize performance in any of several areas. For example, simulations have been designed to maximize the extent to which a scenario can be scaled. Other simulations have been designed to minimize latency, maximize simulation speed, or maximize the fidelity of specific details of equipment operations. To date, however, little attention has been paid to designs that minimize the required communications bandwidth for distributed simulations. There are plans to conduct battle group training while underway using ods that rely on distributed simulations to provide the stimulus to combat systems and operators. For the conduct of such training exercises to be plausible and to minimize interference with the simultaneous normal operations of the battle group, communications bandwidth requirements for of the distributed simulation need to be minimized. Investigations in techniques to accomplish this are therefore necessary.

Data Types: It is assumed that a portion of the installed Navy shipboard voice communications assets will be used for battlegroup training events. The number of channels necessary to support the training event will be determined by the nature and complexity of the planned event and the availability of communications assets not required to support normal shipboard operations. There are typically four data categories or types that are exchanged to facilitate distributed training; training scenario runtime data, tactical voice, tactical link, and training coordination voice.

Training scenario data are the heart of any distributed training event. The data provides the stimulus for exercising the trainee's systems so that they will emerge from the training event having met the training objectives and able to perform at a higher level of skill and proficiency. Under the current Battleforce Tactical Training (BFTT) architecture, one platform or shore site is designated as the scenario generator. That unit uses its BFTT system to generate and distribute the scenario to all participants throughout the course of the exercise conduct. Also, during this time, all participants are expected to execute their mission tasks, and interact with each other, in response to the scenario stimuli.

Tactical voice communications, both Plain and Secure, are essential to implementing an effective engagement strategy and preserving the ability to fluidly react to the dynamics associated with modern warfare. In order to train crewmembers to use their tactical coice communications assets, and to ensure the material readiness of those assets, it is expected that communications circuits will be established during at-sea training events that use the ships' actual communications resources. However, over-the-horizon data communications may be required to bridge the non-line-of-sight battlegroup platforms into the training event.

Coordination voice communications provide the ability to synchronize the flow of training events between multiple participants. Typically, those individuals charged with setting the pace and flow of training scenarios use one or two coordination voice channels. It is desired that the coordination voice channel be transmitted over the same communications channel dedicated to distributing the training scenario.

Tactical data links provide situational awareness fundamental to managing the battle space and executing the desired tactics and strategy. Present BFTT capabilities dictate the use of live tactical data links. However, future BFTT training will include simulated TADIL participants and entities. Thus, bandwidth requirements for TADIL participation during training events will eventually need to be accounted for within the training data link(s).

Bandwidth Requirements: Battlegroup training in an at-sea environment will require establishing training data link (TDL) network connectivity between the participating units. Various categories of traffic will utilize this training network, each providing their own contribution to the total network requirements.

Scenario bandwidth consumption is a function of the nature and complexity of the scenario, which are directly affected by the objectives of the training event. Adequate bandwidth prediction and allocation are essential to a successful training event. This is especially true for training events conducted at sea, due to additional restrictions in available bandwidth, compared to the bandwidth resources available to ships in port.

BFTT bandwidth consumption data has been characterized for a variety of scenario complexities. During one study, ten scenarios were developed. Five of those scenarios consisted of 100, 200, 300, 400, and 500 aircraft flying straight and level. The resulting bandwidth data provided the basis to predict anticipated bandwidth needs for scenarios for varying numbers of low dynamic (LO-DY) entities. The remaining five scenarios consisted of the same numbers of aircraft, however for these scenarios, the aircraft were all in a constant turn. The resulting bandwidth data from these five scenarios provided the basis to predict anticipated bandwidth needs for scenarios consisting of varying numbers of highly dynamic (HI-DY) entities. Table 1 summarizes both the peak and mean bandwidth consumption requirements to support the ten test scenarios.

Table 1: Ethernet Bandwidth Consumption for Scenario Data

No. of Entities	PEAK BANDWIDTH (kbps)		MEAN BANDWIDTH (kbps)	
	LO-DY (4.)	HI-DY (5.)	LO-DY (4.)	HI-DY (5.)
100	57	162	26	122
200	89	281	52	235
300	132	368	77	328

400	202	393	100	352
500	219	403	126	356

A single coordination voice channel consists of communications between training system operators throughout the Pre-Exercise, Exercise, and Post-Exercise phases of training. Experience has shown that this communications channel consumes an average Ethernet bandwidth equal to 21 kbps whenever the microphone for this circuit is keyed.

Based on the data displayed in the table it is possible to predict the approximate Ethernet bandwidth that is currently required for a training exercise, given a description of the scenario to be used in the event. In addition, to minimize the effects of traffic congestion and intermittent disruptions in channel performance, it is good engineering practice to compute the anticipated peak bandwidth, and then increase the allocated channel capacity by at least 25%. The current approach used for pierside BFTT training, is to allocate a full T-1 broadcast-capable network for the training event.

Latency: The latency, or delay, of network traffic between nodes participating in distributed training exercises must be understood and kept to acceptable minimum values. Currently, the BFTT latency specification follows the Distributed Interactive Simulation standard for loosely-coupled simulations, allowing a maximum delay between nodes of 300 ms. It is anticipated that multi-platform training at sea, employing satellite connectivity to shore, will result in latencies exceeding the current specification. The impact of excessive latency on accuracy of scenario realism, often related in terms of the synchrony metric and the probability of kill (PK) metric for threat entities, must be determined. The effects of excessive latency will be exacerbated for engagement profiles involving highly dynamic entities.

Protocols Support: There are a variety of network protocols that must be supported by the communications system.

1) Unicast Traffic: This traffic class is commonly used for point-to-point network communications commonly seen in applications such as: e-mail, file transfers, and Video Teleconferencing (VTC).

2) Broadcast Traffic: This traffic class must be supported by the communications system because it is the primary od by which Distributed Interactive Simulation data, both, scenario and Voice Coordination information, is distributed amongst the training participants. It may be possible to “tunnel” this data or mandate a multicast approach under the High Level Architecture (HLA), divesting of the DIS implementations currently in use.

3) Multicast Traffic: Recent Fleet Battle Experiments have utilized this traffic class to permit the transfer of network traffic over existing satellite links. It is anticipated that this same technology approach will be applied to the at sea training capabilities when especially when over-the-horizon connectivity is required. It may also be appropriate for use when the HLA approach is used to create the simulated training environment.

The research approach envisioned for this effort is described below:

PHASE I: Based on the requirements and assumptions presented above, identify ods that can be used to reduce the bandwidth required to execute distributed training and simulations. Identify the tradeoffs in other aspects of simulation performance required to employ each of these ods. Identify algorithms or rule-based procedures for the employment of each of the identified ods. Where possible, prototype and test various ods for reducing bandwidth, with an emphasis on validating the training objectives can still be met under reduced bandwidth.

PHASE II: Develop procedural guidelines for the employment of each of the identified ods. Incorporate any identified algorithms or rule sets into intelligent agents to assist in the set up and use of the identified ods. Prototype and strate elements of these agents within and actual distributed training system.

PHASE III: Incorporate the intelligent agents into operational training systems that depend on distributed simulations. Assist the appropriate program offices to incorporate the procedural guidelines into their operational procedures.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The developed techniques would be applicable to any military distributed training system. Many of the techniques could also be used to reduce the bandwidth requirements for military or commercial distributed learning systems and thus save bandwidth rental costs.

REFERENCES:

1. Battle Force Tactical Training Operational Requirements Document, February 1992.
2. PMS430, BFTT At-Sea Concept Of Operations, 15 August 2002.
3. Michele Jo Petrovsky, Optimizing Bandwidth, McGraw-Hill Osborne Media, June 16, 1998.
4. Simon St. Laurent, Sharing Bandwidth, Hungry Minds Inc., October 1998.

KEYWORDS: simulation; bandwidth; optimization; agents; distributed; minimize

N03-220 TITLE: Extensible AAR Acquisition, Retrieval, and Storage System (EAARS)

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PEO Integrated Warfare Systems, Integrated Combat Systems Directorate

OBJECTIVE: Develop a scalable, After Action Review (AAR) Data Acquisition, Compression, Retrieval, and Storage System with an extendable HSI for deployment with a variety of Naval and/or Commercial systems that require wideband data capture and management.

DESCRIPTION: Navy simulation/stimulation training systems such as the Battle Force Tactical Training (BFTT) system are increasingly critical in the provision of cost-effective, tactical-training both afloat and ashore. In parallel with the deployment of BFTT, rapid advancement continues in situational awareness information exchange capabilities among Battleforce units. The Joint Forces C4I data interchange capabilities are now data and information-rich; encompassing imagery, video, text chat, and even raw sensor data streams. While technology development has produced audio capture capabilities to support training debrief, there has been no significant advancement in the implementation of multi-format common data acquisition, retrieval, and storage systems capable of simultaneous data capture of such diverse, wide bandwidth data sources as currently being delivered to the Fleet. The typical simulation training system relies heavily on tactical communication networks to support live training audio with no robust means of incorporating the other data networks into an After-Action-Review (AAR). Independent communication systems embedded with the trainers suffer the same shortcomings. Additionally, the ad-hoc use of various analog tape devices for AAR has proven to be inconsistent, omits synchronization with scenario events, and lacks direct access retrieval. While the benefits of simulation/stimulation-based training are well documented and continue to progress it is apparent that a common wide-band data capture solution is needed to shore-up what is considered a fundamental component of the AAR.

EAARS (a conceptual system) is intended to provide audio, imagery, video, and sensor data capture, compression, storage, management, and retrieval that specifically address the need for synchronized, simultaneous multi-input, common-output playback of a training evolution for AAR presentations.

While the actual bandwidth and throughput for voice and tactical data circuits varies greatly with each scenario and ship configuration, a typical exercise would encompass an ISDN-based Primary Rate Interface (PRI) with 22 voice/data channels, 1 radio control/status, and 1 data channel (D). Additionally, multiple C4I circuits are open using the following systems:

a) AN/WSC-8 (Challenge Athena)

b) AN/WSC-6 (SHF)

c) AN/USC-38 (EHF-MDR)

d) EHF-FOT (EHF-MDR)

e) GBS (Ka-band, RCV Only)

f) Ku-band (Commercial – stration)

g) DWTS (L-band LoS)

h) UHF-MDR (UHF LoS)

i) CDL-N/TCDL (X/K-band LoS)

j) CEC (LoS)

k) AN/VRC-99 (L-band LoS – stration).

PHASE I: Perform feasibility concept exploration, researching innovative solutions in wide-band tactical network data acquisition, compression, retrieval, and storage, to include the capacity to distribute independent data acquisition units that acquiesce for a central retrieval system. Investigate international standards for digital formats, current file-shrinking technologies, and innovative solutions to facilitate the reduction of digital storage requirements. Investigate digital distribution and current streaming technologies that offer innovative solutions for a retrieval system. Identify current trends and requirements for multi-channel AD/DA conditioning boards as well as integration solutions for implementing acquisition units. The targeted result of the Phase I effort will be to identify a scalable architecture/design of EAARS that facilitates
(a) reduced digital storage requirements,
(b) direct data access,
(c) common distributed acquisition units,
(d) rapid centralized retrieval for immediate AAR,
(e) and an extendable HSI.

PHASE II: Conduct a prototype stration of a core central retrieval system to retrieve multiple wideband inputs as would be gathered from multiple acquisition sites as discussed above. strate an extendable HSI to access the retrieval system for selective data playback to support a typical AAR presentation. Provide an engineering design for a functioning acquisition unit with the capacity to supply a central retrieval system with multiple independent wideband inputs and the capacity to synchronize time-stamps from an external scenario generation and control system such as BFTT.

PHASE III: Full development and production of software and hardware for an EAARS System for use in Naval as well as Commercial systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Developing a scalable, wideband multi-format, data acquisition, retrieval, and storage system with an extendable HSI for deployment with Naval and/or Commercial systems can be achieved with a combination of current COTS technologies and software development. This provides a common, cost-effective approach to data management to enhance training effectiveness with a more robust and complete AAR of the training evolution. Potential commercial systems include air traffic control, emergency response teams, and fire and law enforcement coordination.

Total Ownership Cost Reduction: The results of this effort will reduce total ownership costs for the Total Ship Training Capabilities through more effective training and debrief of forces afloat. Through more effective delivery of training technologies to the warfighter, efficient use of existing combat systems will increase readiness independent of combat systems technology development.

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1. Battle Force Tactical Training Operational Requirements Document, February 1992.
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3. Daniel Jurafsky, James H. Martin, Speech and Language Processing : An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Pearson Education, January 2000.

KEYWORDS: Software; Acquisition; Conversion; Audio; Digital; Streaming

N03-221 TITLE: Bubble Detection Using Pulse-Echo Ultrasound

TECHNOLOGY AREAS: Biomedical

ACQUISITION PROGRAM: Deep Submergence Biomedical Development Program

OBJECTIVE: Enable researchers in decompression for divers and rescued submarine crew members to determine decompression stress in both animals and eventually human subjects, to produce more accurate decompression schedules with fewer subjects.

DESCRIPTION: Decompression researchers have used Doppler bubble detection for over three decades. Doppler ultrasound devices are interpreted subjectively by listing through headphones and giving a score of one through four. Variability is high, with poor repeatability, among researchers and even for the same researcher. Newer technology using pulse-echo ultrasound can detect, count, and classify emboli in the vascular system. Adaptation of this technology to diving research would add a great measure of reliability to the research. Once this technology became generally available it would enhance safety and reduce decompression sickness risk of commercial divers, and even sport divers who are diving long and deep schedules.

PHASE I: Determine feasibility to detect bubble emboli both in medium-sized animals often used in diving research and in humans (also, analyze existing pulse-echo ultrasound apparatus and detector algorithms). Test the system at normal atmospheric pressure.

PHASE II: Test the system in hyperbaric chambers using various pressures with medium sized animals such as small pigs, followed by testing in hyperbaric chambers during animal decompression research. Adapt the apparatus to human use and use the system during human experimental diving studies.

PHASE III: Support the development of the product into a commercially available apparatus usable with limited training by diving and medical professionals. Introduce its use at the Navy Experimental Diving Unit, a field activity of Naval Sea Systems Command, as a standard procedure to be used to monitor safety and efficacy for all decompression studies.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Most decompression studies are done by the Navy, or supported by Navy funds. There are limited studies done by several universities that could clearly benefit from this technology. In addition there are many commercial diving operations, such as the petroleum industry, which require divers to use deep, long schedules with a significant risk of decompression sickness, and which would benefit by the greatly increased precision of the proposed system.

REFERENCES:
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2. Nishi RY. Doppler and ultrasonic bubble detection. The Physiology and Medicine of Diving, 4th Ed., 1993, Bennett P and Elliott D eds., Chap 15, pp 433-453.

KEYWORDS: decompression, Doppler, ultrasound, embolism, venous, pulse-echo

N03-222 TITLE: Multiple-Beam Electron Gun for Radar Applications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

OBJECTIVE: To develop a multiple-beam electron gun for a high average power multiple-beam amplifier (MBA) that can address a variety of DoD radar and communications systems applications.

DESCRIPTION: MBAs are attractive because they represent a device technology with the potential to produce compact, low-weight, low-noise, lower voltage, wide-bandwidth amplifiers capable of providing the high peak and average power performance required to keep pace with evolving DoD needs. The main focus of the project is the development of a multi-beam electron gun and beam transport system capable of generating/propagating an electron beam with a peak power of ~1.6 MW at a high pulse repetition frequency (PRF) and with minimum beam-circuit interception. Specifi-cally, the goal is to demonstrate the generation and modulation of eight parallel beams at 45 kV and a total current of 35 A. The gun must be capable of supporting PRFs between 400 Hz and 1000 Hz. The maximum pulse duration is 100 ƒÝsec (consistent with a maximum duty factor of 4%). The beam must be fully turned off between the pulses. The pulse rise and fall times should be less than 100 nsec. An eight-beam multiple beam klystron circuit will be supplied as GFE in order to assess the gun design and beam transport.

PHASE I: Complete an initial electromagnetic, mechanical and thermal design of a multiple beam electron gun using 3-D design tools such as the electromagnetic solver HFSS, gun/collector code MICHELLE, magnetic field design code MAXWELL-3D, and thermo-mechanical analysis code ANSYS. Different approaches for achieving beam modulation should be investigated and compared, such as grid pulsing, control electrode pulsing, and cathode pulsing. All the above codes are accessible at the Naval Research Laboratory and will be made available to the program at no cost. Develop the specification requirements for a solid-state high voltage power supply/modulator sys-tem consistent with gun performance requirements described above.

PHASE II: Using the gun design results of Phase I, fabricate an 8-beam multiple-beam gun and beam transport system and integrate it with the MBA circuit provided as GFE. Experimentally demonstrate that the pulsed performance of the system meets the required specifications with mini-mal beam interception (>95% beam transmission). The gun performance will be tested at low-duty (<0.2%) using an NRL modulator provided as GFE. At present, the NRL modulator supports cath-ode-pulsed operation only; if a different modulation scheme is required, work with NRL staff to de-sign/implement the necessary modifications.

PHASE III: Integrate a high average power MBA into a DoD relevant transmitter system. De-velop a production system for the proposed application. Transition to commercial markets and non-SBIR funded programs through the sale of derivative proof of concept units to private corporations and government agencies who own, operate or maintain the system for the proposed application.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial applications of multiple-beam amplifier technology include broadband high-power amplifiers for commercial satellite up-links and high-energy accelera-tors, where the low operating voltage is attractive due to reduced costs and increased reliability.

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1. E.A. Gelvich, et al, "The new generation of high-power multiple-beam klystrons," IEEE MTT Transactions, 41, pp.15-19 (1993).

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on multi-beam klystron¡¨, ibid. pp. 126-135

5. K.T. Nguyen, D. Pershing, J. Pasour and J. Petillo ¡§Multiple-beam electron gun development for high-power amplifiers¡¨, 3rd IEEE Int. Vacuum Electronics Conference, IVEC 2002, April 23-25, Monterey, CA USA, 02EX524.

KEYWORDS: multiple beam klystron, multiple electron beams, multiple-beam amplifiers, MBK

N03-223 TITLE: Autonomous Biological and Chemical Oceanographic Instrumentation

TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors, Electronics, Battlespace

OBJECTIVE: To develop low-weight, low-power, autonomous sensors and sensor-systems to measure biological or chemical oceanographic parameters in the ocean during long-term, unat-tended deployments

DESCRIPTION: Innovative sensors and sensor systems capable of long-term (weeks to months) autonomous operation in situ are solicited in order to detect biological or chemical oceanographic parameters at high frequency (temporal resolution of seconds to minutes). Emphasis should thus be placed on: (1) developing individual sensors, sensor systems or instrument arrays which can conduct measurements autonomously (i.e. for independent operation on fixed moorings, Autonomous Underwater Vehicles (AUV's), gliders, profiling moorings or floats, or with ex-pendable instruments); (2) providing a significant reduction in instrument weight and power re-quirements without compromising sensitivity, reliability or resolution as compared to current state-of-the-art devices; (3) achieving a high level of specificity in detection of each biological (pigment class, biological taxon or species) or chemical (chemical ion, compound or class of compound) parameter; (4) developing the next generation of low cost, potentially expendable instrumentation usable in both navy operational scenarios as well as in environmental data col-lection; and (5) incorporating on-board data processing to sensor systems, as appropriate. Exam-ples of some of the types of instruments solicited include: (1) in situ sensors to detect solutes, metal ions, or biota that could be incorporated into autonomous glider or AUV designs; (2) high resolution autonomous profiling moorings used for biological or chemical detection and ideal for long-term deployment, or (3) low cost oceanographic expendable instrumentation capable of bio-logical or chemical measurement. Note that the term “expendable instrumentation” here includes either one-time usage or long-term in situ usage where the probability of instrumentation loss is not insignificant, but the data are collected remotely via telemetry and therefore not lost. "Ex-pendable" sensors should be affordable if expendability is required but reusable if not. Included are instrumentation development efforts that would result in significant improvements in current in situ sensitivity, specificity or reliability, and cost savings for existing expendable instrumenta-tion, or that would develop new expendable capabilities for measurements currently obtainable by other means, or would significantly expand the range of utility of existing techniques.

PHASE I: Provide both a system design concept and a feasibility analysis (including es-timated sensor accuracy and sensitivity as well as system requirements, durability and re-liability)

PHASE II: Develop a prototype of the sensor or system and demonstrate its ability to support field measurements as described in Phase I

PHASE III: Transition the system to scientific use in the coastal and oceanographic moni-toring or research communities.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The coastal and oceanographic science and monitoring communities are currently greatly restricted in their capacity to measure a wide range of biological and chemical properties of seawater using reliable sensors on autonomous plat-forms. This lack of capabilities hinders the detection of pollutants (both organic and metal), chemical stimulants of biological production, and harmful algal blooms, and restricts basic bio-logical and chemical monitoring efforts. Various management, research and defense oriented industries/organizations would benefit from access to reliable, commercially available instru-ments and sensors for the long-term, in situ detection of solutes, metals and biological properties of coastal and open-ocean environments. Enhancing existing instrumentation potential as pro-posed here has been identified as a priority issue in the expansion of coastal and ocean observing systems, per Ocean.US, the office established to with coordinate a U.S. integrated and sustained ocean observing system. Advancements in ocean observing technologies, such as the develop-ment of in situ sensors capable of more accurate measurements and extended deployments, are thus important to a large group of stakeholders including those in the research, management and defense sectors.

REFERENCE:

1. http://www.ocean.us/documents.jsp

KEYWORDS: oceanography; sensors; autonomous instrumentation; chemical; biology; expend-able

N03-224 TITLE: Sensor/Sensor – Sensor/Weapon Connectivity Technology

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMA-264 - Air Anti-Submarine Warfare (AAASW) Systems, PMS-183

OBJECTIVE: Enable distributed sensors to efficiently compress and exchange information so as to autonomously develop a description of the surrounding battlespace and their relationship to relevant items within that space.

DESCRIPTION: Distributed sensors are being developed to acquire information for the detection and tracking of submarines and other underwater vehicles. These sensors may be fixed, drifting or mobile and may include sensor suites on weapons. The sensor systems are typically made up of clusters of autonomous distributed sensor nodes exchanging and fusing information. A cluster may consist of as few as four to five nodes or may be a field of tens or hundreds. A representative example is depicted in reference 1.
To construct a useful picture of the battlespace around a sensor, information from other companion sensors needs to be exchanged and fused. Connectivity may be achieved by acoustic (see reference 2 for an example), RF (either line of sight or satellite) or a combination of the two. Information exchange has a cost in power and time; therefore data compression and power efficient communication protocols are an issue. Data compression techniques have been widely addressed in recent literature, reference 3 is one example. Between a 10-to-1 and a 12-to-1 lossless or near lossless compression of raw acoustic sensor data is desired. The covertness of the information exchange is also an important issue in many of our applications especially underwater acoustic communication. Algorithms which efficiently extract appropriate data from distributed sensors and apply the information to impact system operation such that the mission objectives are accomplished must be developed and demonstrated.

PHASE I: Develop an initial concept design and model key elements of a power and time efficient communication algorithm suitable for use in distributed sensors systems. Complete a detailed analysis and predict the performance of the communication algorithm. Develop a plan to demonstrate the technology in Phase II

PHASE II: Develop, demonstrate and validate the technology described in Phase I using real sensor data to enable the exchange and assimilation of battlespace data in a distributed sensor or sensor & weapon system.

PHASE III: Develop the product of Phase II and implement it on a current developmental or operational system for at-sea demonstration.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be applied to any system using distributed sensors netted by way of a band limited link, e.g. acoustic or RF. Potential application to free swimming oceanographic instrumentation packages.

REFERENCES:
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2. Proakis JG, Sozer EM, Rice JA and Stojanovic M, "Shallow Water Acoustic Networks," IEEE Communications Magazine, 39 (11) Nov. 2001, pp. 114-119
3. 14th International Conference of Digital Signal Processing, IEEE 2002.

KEYWORDS: Network, automation, sonar, data-fusion, data-compression, communications

N03-225 TITLE: Underwater X-ray imager and scatterometer for ROVs and AUVs

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: Mine Warfare Thrust

OBJECTIVE: To develop a buried mine-like object imaging capability suitable for small un-derwater vehicles, including remotely operated vehicles (ROVs) and autonomous underwater ve-hicles (AUVs). Specifically, the image quality should be adequate for target classification purposes. A secondary objective is to develop a capability to obtain sediment property es-timates, such as porosity and structure, from the backscattered signal.

DESCRIPTION: Since the seabed is opaque, it is very difficult to obtain images of objects that are buried within. The ability to image buried mines and mine-like objects, buried in the upper sediment layer of the seabed, from a ROV or AUV is very desirable. There are a number of pro-jects in this area that use acoustic means. This project seeks to explore the application of X-rays as an alternative means.

From medical applications, it is clear that x-rays can travel through water and can give clear images of underwater objects. X-ray scatterometer measurements can provide a non-invasive measurement of the sediment porosity and microstructure[1], which has many uses in sediment classification and acoustic modeling. It may even be possible to detect the presence of explosive material by the x-ray diffraction pattern[2]. X-ray imaging should be able to provide high quality images [3,4] of buried objects at short range.

The processing of the backscattered signal for imaging and other purposes needs further development. The instrumentation issues are expected to be power consumption, size, weight and cost. The application issues are range, penetration depth, calibration accuracy in the case of scat-terometry and image resolution in the case of target imaging.

PHASE I: A feasibility study that should include the following. (a) Algorithm definition: The process of image reconstruction from X-ray backscatter will be formulated, including the specification of all pertinent system and perform-ance parameters. The process of backscatter processing for sediment porosity and structure will be formulated. (b) Instrument design: A preliminary instrument design, with estimates of power consumption, size, weight and cost.

PHASE II: Development of a prototype, including algorithm development and instrument construction, followed by a laboratory demonstration.

PHASE III: At sea demonstration and data collection under a wide range of operating conditions. Sufficient quantities of data are needed to make statistically significant measurements of performance. A final design will be defined.Transition, possibly including a technical demonstration with an existing fleet system or in an experimental system that is still under development.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The instrument has potential uses in a number of civilian applications, including the detection and estimation of buried marine biologi-cal organisms, the estimation of seafloor properties for structural purposes, and in searching for buried artifacts.

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KEYWORDS: X-ray, buried mines, imaging, sediment properties, scattering

N03-226 TITLE: <u>Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop and demonstrate autonomous signal processing and data fusion technology that can improve littoral battlespace awareness for Naval forces conducting anti-submarine warfare (ASW) and/or mine countermeasure (MCM) missions.

DESCRIPTION: The focus of this SBIR topic is on basic and applied research or advanced technolgy concepts to enable ASW and MCM commanders utilizing maritime ISR assets to better understand the littoral battlespace and reduce the time it takes to shape the battlespace. The presence of many neutral surface ships of all sizes and purposes as well as friendly and enemy combatants, including mines complicate the battlespace. Methods of detecting and classifying (or, in some cases, identifying) neutrals (commercial shipping, fishing and pleasure craft) and unusual threats such as small surface craft (i.e. "Boghammers") and small submarines (diesels or mini-submarines) is critical. Novel means of exploiting information from sensors, including space-based sensors are of interest. Methods of detecting, localizing and tracking entities of interest in the complex littoral environment are sought. Emphasis should on concepts with false alert rates of less than one per day or better while maintaining a probability of detection of greater than 85%. Probabilities of correct classification should exceed 50% while maintaining very low probabilities of false dismissal. Algorithms that are power efficient for autonomous covert operation are preferred. The ultimate goal is to maintain a consistent awareness of the battlespace among warfighters who are dispersed and intermittently in contact with each other. Related interests include improved specification of environmental parameters affecting signal detection to include techniques and sensors for ionospheric specification and novel techniques for ionospheric and atmospheric remote sensing such as bistatic GPS.

PHASE I: Demonstrate the feasibility of the concept for the algorithm. Develop a detailed description of the proposed ISR concept. The algorithm, description, or design and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: : Produce and demonstrate performance of a prototype algorithm. Demonstrate performance in such a way as to convince qualified engineers that the proposed concept is capable of meeting requirements in an operational environment.

PHASE III: Working with Navy Program Offices, integrate real-time algorithms into existing and/or future ASW or MIW ISR systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These algorithms have potential spin-off application in other areas such as marine mammal detection and mitigation, fisheries monitoring, and underwater search and recovery.

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KEYWORDS: Electromagnetic, Acoustic and Hydrodynamic signatures, signal processing, classification, multitarget tracking, state estimation, common tactical picture

N03-227 TITLE: Aerosol Mass Spectrometer for Aircraft Sampling.

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop an aerosol mass spectrometer for measurement of size- and chemically-resolved atmospheric aerosol concentrations from an airplane or other moving platforms.

DESCRIPTION: There is a critical need for quantitative size and composition measurements of atmospheric aerosols from aircraft platforms with high time resolution. Aerosol mass spectrometers are ideally suited for this application due to their high inherent sensitivity and time response. These instruments sample particles into high vacuum, measure their size via different techniques, and obtain chemically-resolved concentrations data via a one- or two-step vaporization/ionization process followed by mass spectrometric analysis of the ions produced.

Several new challenges arise for adapting aerosol mass spectrometer to aircraft platforms. First, the sensitivity of the instrument shall support sampling aerosol in clean marine regions with high time (and thus spatial) resolution. Second, the detection regions of these instruments often need to be maintained under high vacuum and moderately high temperature between flights in order to maintain a clean vacuum and thus reduce background noise in the chemical measurement. The instrument developed with this project should address and overcome those and other obstacles associated with aircraft deployment.

The aerosol mass spectrometer should be transferable onto a variety of aircraft. Power for the instrumentation will be provided from the aircraft's 28V DC generators, and some data from the instrument should be passed to the aircraft's data system. Consideration should be given to minimizing both size and power requirements.

PHASE I: Describe plans for feasibility and performance for different approaches for an airborne aerosol mass spectrometer.

PHASE II: Develop and demonstrate an aerosol mass spectrometer for use on a research aircraft. Develop a commercialization plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition the system into an operational Aerosol Mass Spectrometer to include documentation, calibration and other tools and spare parts. Support Aerosol Mass Spectrometer integration for government customer-specified platforms. Finalize requirements for an Aerosol Mass Spectrometer system that would allow its utilization by various research facilities on a variety of platforms, including aircraft, ships and ground based operations.

COMMERCIAL POTENTIAL: This low-cost stand-alone mobile package will provide size- and composition-resolved aerosol data in real time. The instrument will attractive to research universities as well as to ship and aircraft operators, and it may have land-based pollution monitoring applications also.

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KEYWORDS: Real-time Data Collection; Aerosol Mass Spectrometer; Sensitivity Enhancement.